

HydroBank[®] MS

Compact, Single Stage Water Source Heat Pumps

½ to 6 Tons – Horizontal and Vertical



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Introduction

This manual provides guidelines for installation, startup, operation and maintenance of Mammoth HydroBank vertical and horizontal water source heat pumps. Installation, startup and operation of this unit must follow accepted industry practices as described in the ASHRAE Handbook, the National Electric Code, and other applicable standards. Operate this equipment in accordance with regulations of authorities having jurisdiction and all applicable codes. Maintenance and service must be performed by qualified personnel familiar with applicable codes and regulations and experienced with this type of equipment.

If you have additional questions about the operation or maintenance of your Mammoth system, contact your local Mammoth representative. For assistance in locating your Mammoth representative, go to www.mammoth-inc.com and click on the Find a Rep link. Or, call 952-358-6600 or send an email to info@mammoth-inc.com.

Warnings, Cautions and Important Notices

Warnings, cautions and important notices appear at appropriate locations throughout this manual. Your personal safety and the proper operation of this machine depend upon the strict observance of these precautions. Read this manual thoroughly before operating or servicing this unit.



WARNING! Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION! Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury. It could also be used to alert against unsafe practices.

IMPORTANT: Indicates a situation that could result in equipment or property-only damage.

General Warnings



WARNING! Electric shock and moving equipment hazard. Can cause severe injury or death. Lock and tag out all electric power before servicing equipment. More than one disconnect may be required to de-energize the unit.



WARNING! The installer must determine and follow all applicable codes and regulations. This equipment presents hazards of electricity, rotating parts, sharp edges, heat and weight. Failure to read and follow these instructions can result in property damage, severe personal injury or death.



CAUTION! Installation and servicing of this equipment should only be undertaken by a trained professional with experience working on commercial HVAC systems. Contact your Mammoth representative for help in installing this equipment or scheduling service.



CAUTION: Sharp edges on sheet metal, coil surfaces and fasteners can cause personal injury. Avoid contact and wear protective clothing and gloves.

Nomenclature

1		2		3	4	5		6		7		8	9	10	11	12	13	14	15	16	17		18	
M		S		H	1	0		1		9		D	L	S	E	S	A	C	Y	1	0		1	
Digits 1-2: Model Type MS = Standard Efficiency																		Digits 17-18: Cabinet Finish 01 = Standard Galvanized XX = Special						
Digit 3: Cabinet Type H = Horizontal V = Vertical																		Digit 16: Filtration 1 = Standard 1" w 1" Throwaway 2 = 4-Sided 2" w 1" Throwaway 3 = 4-Sided 2" w Merv8 4 = 4-Sided 2" w Merv13 X = Special						
Digit 4: Design Series 1 = A Design																								
Digits 5-7: Nominal Capacity 006 = 6,000 036 = 36,000 009 = 9,000 040 = 40,000 (Vertical Only) 012 = 12,000 042 = 42,000 015 = 15,000 048 = 48,000 019 = 19,000 060 = 60,000 024 = 24,000 070 = 70,000 030 = 30,000																								
Digit 8: Voltage A = 115/60/1 F = 208-230/60/3 D = 208-230/60/1 G = 460/60/3 E = 265-277/60/1																								
Digit 9: Return Air L = Left R = Right								Digit 10: Discharge Air T = Top S = Straight E = End																

	19	20	21	23	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44							
	Y	Y	Y	Y	Y	Y	M	V	Y	0	1	H	G	B	W	S	E	C	M	R	Y	Y	Y	S	1	B							
Digits 19-21: Heating Option YYY = None (standard) XXX = Special																											Digit 44: Build Type A = Stock finish good B = Configured to order C = Special build						
Digits 22-23: Reserved - Future YY = None (standard)																											Digit 43: Warranty 1 = 1 Yr Delayed Startup Ext Warranty 2 = 2nd Yr Refrig Circuit Parts 3 = 2nd Yr Complete Unit Parts 4 = 2-5 Yr Compressor Only 5 = 2-5 Yr Refrigerant Circuit Parts 6 = 2-5 Yr Complete Unit Parts Y = Standard Factory Warranty X = Special						
Digit 24: Heat Recovery Y = None (standard)																																	
Digits 25-26: Fluid Flow Control MV = 2-way Motorized Valve YY = None (standard) XX = Special																																	
																														Digit 42: Condensate Pan S = Galvanized Steel T = Stainless Steel			
																														Digit 41: Switching Devices A = Unit Disconnect Switch B = Water Differential Pressure Switch (DPS) C = Dirty Filter Switch D = Combo - Disconnect & Dirty Filter Switch E = Combo - Disconnect & Diff Pressure Switch F = Combo - Disconnect, Diff Pressure, Filter G = Combo - Differential Pressure & Dirty Filter Y = None (standard) X = Special			
																														Digits 39-40: Reserved - Future YY = None			
																														Digits 36-38: Monitoring Devices CMR = Compressor Monitor Relay BMR = Blower Monitor Relay PHM = Phase Monitor Device CBR = Compressor & Blower Monitor Relays CPM = Compressor & Phase Monitor BPM = Blower & Phase Monitor CBP = Compressor, Blower & Phase Monitor YYY = None (standard) XXX = Special			

General Information

Receiving Inspection

When receiving equipment, check the Bill of Lading to verify that all crates and cartons have been received. Compare shipped-loose items received against the list provided. Check for damage. Claims for loss or damage must be made with the carrier.

IMPORTANT: This product was carefully packed and thoroughly inspected before leaving the factory. Responsibility for its safe delivery was assumed by the carrier upon acceptance of the shipment. Claims for loss or damage sustained in transit must therefore be made upon the carrier as follows. Take detailed photos for documentation.

Visible Loss or Damage

If there is any external evidence of loss or damage, refuse delivery of the damaged item. Refusal of items must be noted on the freight bill or carrier's receipt, and signed by the carrier's agent. Failure to adequately describe such external evidence of loss or damage may result in the carrier's refusal to honor a damage claim.

Concealed Loss or Damage

Concealed loss or damage means loss or damage which does not become apparent until the product has been unpacked. When the damage is discovered, make a written request for inspection by the carrier's agent within fifteen (15) days of the delivery date and file a claim with the carrier,

Storage

Equipment should be stored in its original packaging. Temporary storage at the job site must be indoors, completely sheltered from rain, snow, etc. High or low temperatures naturally associated with weather patterns will not harm units. Excessively high temperatures, 140°F (60°C) and higher, may deteriorate certain plastic materials and cause permanent damage. Keep units upright.

IMPORTANT: Operating a unit after it has been stored or transported on its side can result in serious compressor damage which is not covered under the equipment warranty. Make sure the unit is first returned to its normal upright position for at least 24 hours before operating.

Unit Protection

Keep units covered during construction to protect components from dust and other harmful material. Cap the ends of all open pipes. This is critical while spraying fireproofing material on bar joists, sandblasting, spray painting and plastering. Physical damage or contamination may prevent unit startup and result in costly cleanup.

IMPORTANT: To prevent equipment damage, units should not be operated for supplementary heating and cooling during the construction period.

Pre-installation Checklist

- Inspect the unit for any specific tagging numbers indicated by the factory per a request from the installing contractor.
- Check the unit nameplate for the size and voltage rating and confirm against the plans that the unit is being installed in the correct location.

IMPORTANT: Check the unit name plate for correct voltage with the plans before installing the equipment. Make sure all electrical connections are made in accordance with national (NEC) and local codes.

- Verify the installation location with the piping, sheet metal and electrical contractors prior to installation.
- Verify all clearances are available for the unit prior to installation.
- Note the location and routing of water piping, condensate drain piping, and electrical wiring. The locations of these items should be clearly marked on the unit submittal drawings.

IMPORTANT: Remove the shipping block from the blower housing opening before starting the unit! See figure below. Failure to do so may result in poor blower operation or motor failure.



Horizontal Unit Installation

Unit Location

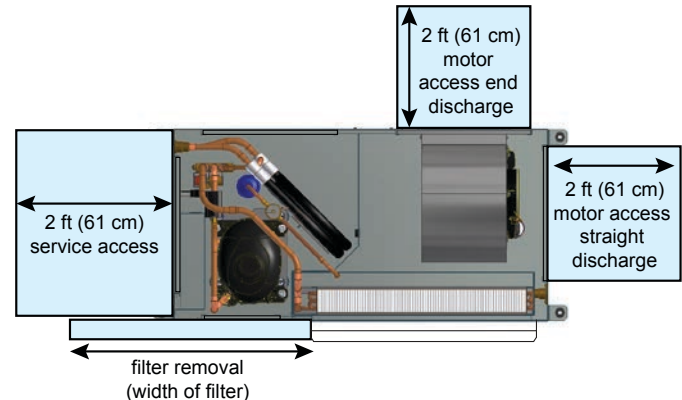
Do not locate units above noise-sensitive areas such as offices, meeting rooms, and classrooms. If possible, avoid locations above areas where there is considerable traffic as service time may be limited during occupied hours. Placing units above hallways is a typical location in schools to avoid potential noise problems, with supply and return air ducted to adjacent classrooms. Such locations may limit service time during school hours.

IMPORTANT: This equipment is designed for indoor installation only. Sheltered locations such as attics, garages, etc., generally will not provide sufficient protection against extremes in temperature and/or humidity, and equipment performance, reliability, and service life may be adversely affected.

Suggested Clearances

Units should be positioned to provide clearance to perform routine maintenance or service, including easy filter replacement. Figure 1 shows suggested clearances. Any additional clearances would be beneficial, but are not always necessary. The requirements on any specific unit may increase or decrease depending on factors such as electrical installation codes. If return air is not ducted, be sure to provide enough clearance for adequate airflow.

Figure 1: Suggested Horizontal Unit Clearances

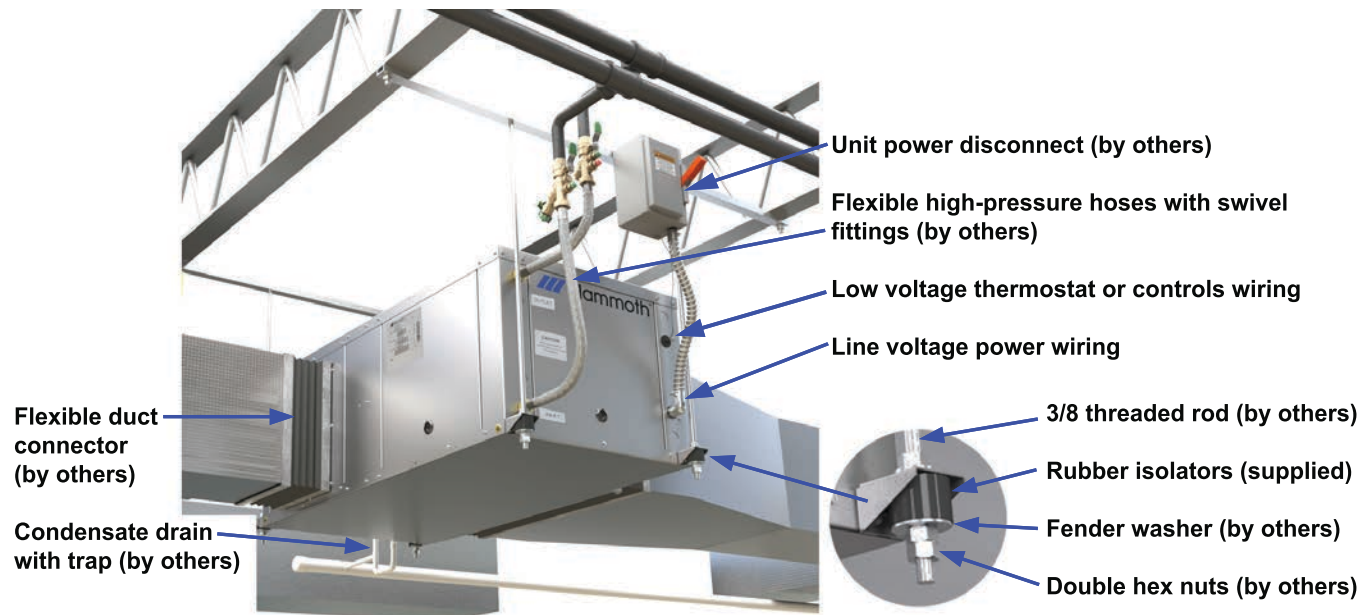


Mounting

Horizontal units are typically suspended from the ceiling using four 3/8 inch threaded rods (supplied by others). The rods should be attached to building structural members. Slide the rods through the mounting brackets and rubber isolators provided on each corner of the unit. The mounts can be repositioned from the end to the side of the unit to accommodate installation requirements. See "Repositioning Mounting Brackets" on page 8.

Connect the rods to the mounts using a fender washer and double hex nuts. The fender washer should cover the entire bottom of the rubber isolator. See Figure 2. When installed, the unit should be slightly pitched toward the condensate drain connection.

Figure 2: Typical Horizontal Unit Installation

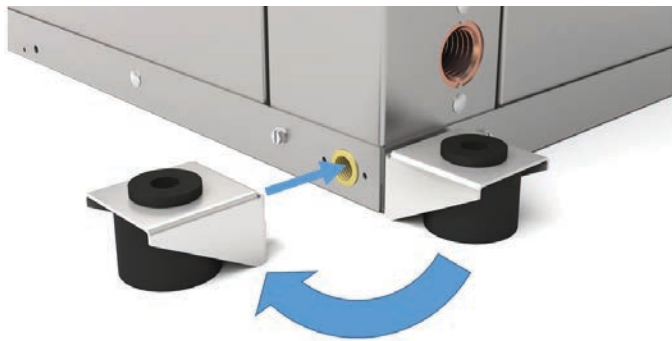


Repositioning Mounting Brackets

Horizontal unit mounting brackets can be repositioned from the end to the side of the unit as needed to accommodate installation requirements, as follows.

1. Raise and support the corner of the unit to provide access to the mounting bracket.
2. Carefully pry the rubber isolator out of the bracket.
3. The mounting bracket is held in place with two sheet metal screws and one mounting bolt. Remove all three fasteners and set aside for reassembly.
4. Move the mounting bracket from the end to the side of the unit, or vice-versa (see Figure 3).
5. Screw the center mounting bolt into the provided connector and finger-tighten.
6. Align the mounting bracket with the unit and screw in the sheet metal screws in the holes provided.
7. Tighten the center mounting bolt to 17 ft-lbs.
8. Remount the rubber isolator in the mounting bracket.

Figure 3: Repositioning Mounting Brackets



Field Conversion of Air Discharge

The blower on horizontal units can be field-converted from straight to end discharge or vice-versa as needed to meet application requirements, as follows.



WARNING! Electric shock and moving equipment hazard. Can cause severe injury or death. Lock and tag out all electric power to the unit before beginning.

9. Remove the sheet metal screws securing the unit top and set aside for reassembly.
10. Remove the top from the unit and set aside.
11. Slide out the access panel from the end of the unit on straight discharge units and from the side of the unit on end discharge units.
12. Disconnect the electrical wiring from the motor.
13. Slide the blower housing and motor assembly vertically upward and out of the unit.

14. Rotate the assembly 180 degrees and turn it 90 degrees, as shown in Figure 4.
15. Slide the assembly into the slot from which you removed the access panel.
16. Verify that, in its new configuration, the orifice ring on the blower motor faces the access opening on the side or end of the unit.
17. Reconnect the wiring to the motor.
18. Slide the access panel into its new location on the side or end of the unit.
19. Reinstall the unit top, using the sheet metal screws removed earlier.

Figure 4: Field Conversion of Air Discharge



Piping

Heat pumps are typically connected to supply and return piping in a two-pipe, reverse-return configuration, which is inherently self-balancing. It also requires only trim-balancing where multiple heat pumps with different flow and pressure drop characteristics exist in the same loop.

Supply and return run-outs usually join the heat pump via short lengths of high-pressure, flexible hose which serve as sound attenuators for both heat pump operating noise and hydronic pumping noise. One end of the hose should have a swivel fitting to facilitate removal for service. Make sure that threaded fittings are sealed. Teflon tape can be used to provide a tight seal.

Hard piping is not recommended since it does not provide vibration or noise attenuation. If used, it must include a union to facilitate heat pump removal. Avoid dissimilar metal fittings as they may corrode. If unavoidable, use dielectric isolation at the connection point.

Supply and return shutoff valves are required at each heat pump. The return valve may be used for balancing. It should have a "memory stop" so that it can always be closed off but can only be reopened to the proper position for the flow required.

No heat pump should be connected to the supply and return piping until the water system has been cleaned and flushed completely. See "Cleaning and Flushing the Water System" on page 23.

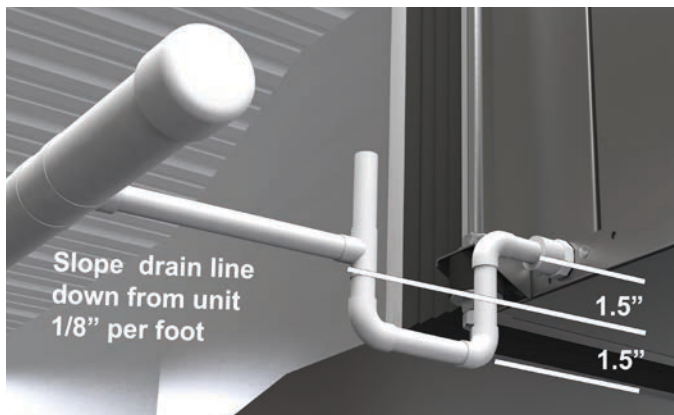
Check for proper water balance by measuring the differential temperature reading across the water connections. To ensure proper water flow, it should be between 10°F and 14°F for heat pumps in the cooling mode.

Condensate Drain Piping

A flush-mounted drain connection is provided on the outside of horizontal cabinets, on the end opposite the water line connections. Condensate piping can be PVC, steel or copper. PVC typically eliminates the need to insulate the pipe to prevent sweating.

A condensate trap that has a depth of at least 3 inches or 2.5 times the expected negative static pressure of the unit must be provided. The condensate pipe run must slope away from all units at least 1/8 inch per foot. The trap may be constructed of PVC, copper or steel. Piping should be vented, with the vent after the trap. See Figure 5 below for an example. Refer to local codes for the correct condensate piping to drains.

Figure 5: Vented PVC Condensate Trap by Others



Ductwork and Sound Attenuation

Horizontal, ceiling-mounted heat pumps virtually always have discharge ductwork attached to the unit. A collar is provided on the discharge to facilitate attachment to the ductwork. Ductwork should conform to industry standards. See Figure 6 below and "Discharge Duct Sizing Considerations" on page 12.

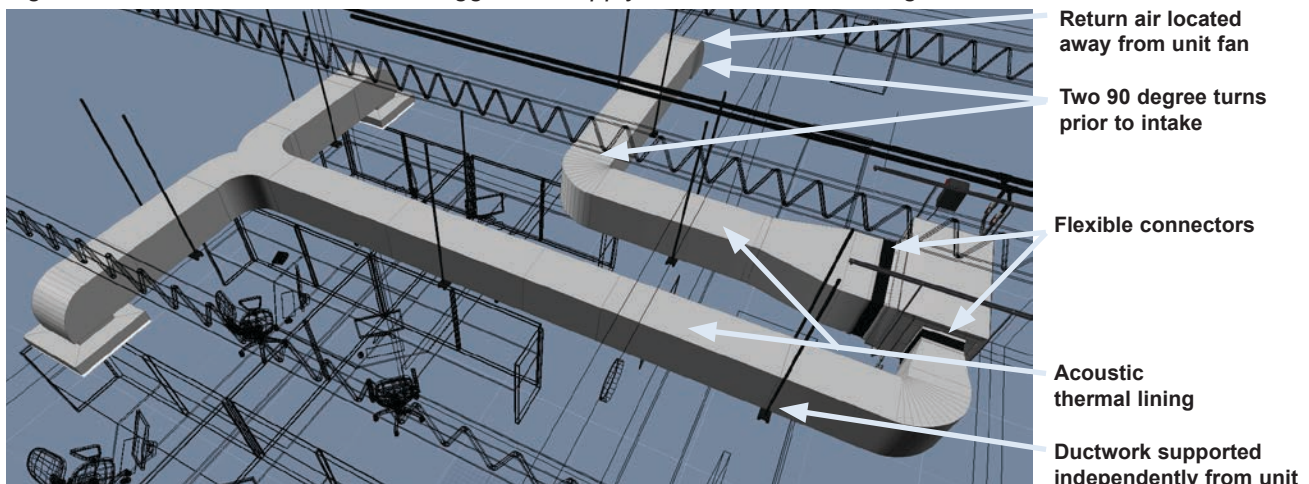
Good design practice requires a flexible connector between the collar and transition to the main duct system. This connector attenuates sound from the unit, especially fan sound, and simplifies unit removal.

Ductwork should be lined with an acoustic, thermal insulation that is a minimum of ½ inch thick. For sensitive installations, use 1-inch insulation a minimum of five to 10 feet prior to each diffuser. For applications that are especially acoustically sensitive, consider an acoustic kit that includes additional unit lining and dampening material beneath the entire unit.

Ducted returns may be used on horizontal units for acoustically sensitive applications. Return ducting should extend at least 12 inches from the coil before transitioning to provide even air distribution across the coil. A flexible connector should be used to connect the unit to the return ducting to attenuate unit sound levels and allow ease of unit removal. The filter section is supplied with a bracket to accommodate return ductwork.

Changes in duct direction and internal devices such as dampers that create airflow turbulence can increase acoustic problems. Minimize these items where possible. Placing a straight run of duct between fittings will decrease turbulence and associated noise. Diffusers located in the bottom of a trunk duct pose acoustical problems. Volume control dampers should be placed well upstream of any air outlets.

Figure 6: ASHRAE AND SMACNA Suggested Supply and Return Air Ducting



Vertical Unit Installation

Location

Vertical units are typically installed in a small mechanical room or closet, with discharge ductwork routed overhead into the conditioned space. See Figure 8. Return air may be ducted or non-ducted. If non-ducted, provision must be made for return air to freely enter the mechanical room. This is often accomplished by using a louvered door at the entrance. A sound baffle may be needed on the door to attenuate noise from the unit.

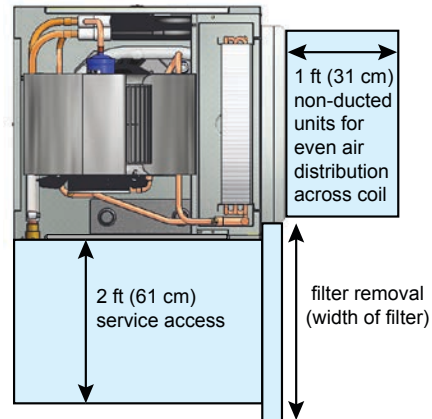
IMPORTANT: This equipment is designed for indoor installation only. Sheltered locations such as attics, garages, etc., generally will not provide sufficient protection against extremes in temperature and/or humidity, and equipment performance, reliability, and service life may be adversely affected.

Install the unit on a rubber or neoprene mounting pad for sound isolation. The pad should be at least 3/8 inch thick.

Suggested Service Clearances

Figure 7 shows minimum suggested clearances. Any additional clearances would be beneficial, but not always necessary. Units need to be accessed from the front to change the filter and to access the electrical panel, blower motor, air coil and compressor compartment. The requirements on any specific unit may increase or be reduced depending on several factors such as maintenance requirements and mechanical or electrical installation codes.

Figure 7: Suggested Vertical Unit Clearances



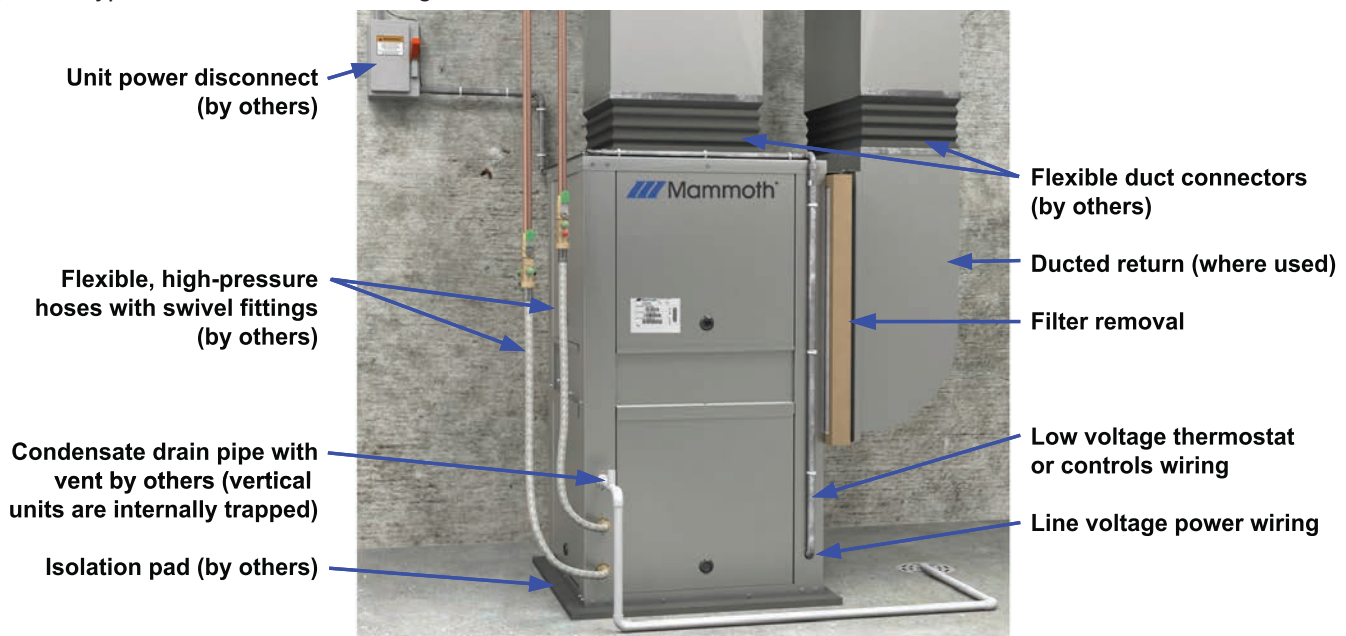
Piping

Heat pumps are typically connected to supply and return piping in a two-pipe, reverse-return configuration, which is inherently self-balancing. It also requires only trim-balancing where multiple heat pumps with different flow and pressure drop characteristics exist in the same loop.

Supply and return run-outs usually join the heat pump via short lengths of high-pressure, flexible hose which serve as sound attenuators for both heat pump operating noise and hydraulic pumping noise. One end of the hose should have a swivel fitting to facilitate removal for service. Make sure that threaded fittings are sealed. Teflon tape can be used to provide a tight seal.

For geothermal applications, all water lines and valves should be insulated to prevent condensation.

Figure 8: Typical Vertical Unit Mounting



The piping may be steel, copper, or PVC. Avoid dissimilar metal fittings as they may corrode. If the use of dissimilar metals is unavoidable, use dielectric isolation at that connection point.

Supply and return run-outs usually join the heat pump via short lengths of high-pressure flexible hose which are sound attenuators for both heat pump operating noise and hydraulic pumping noise. One end of the hose should have a swivel fitting to facilitate removal for service.

Hard piping is not recommended since it does not provide vibration or noise attenuation. If used, it must include a union to facilitate heat pump removal. Avoid dissimilar metal fittings as they may corrode. If unavoidable, use dielectric isolation at the connection point.

Supply and return shutoff valves are required at each heat pump. The return valve may be used for balancing. It should have a “memory stop” so that it can always be closed off but can only be reopened to the proper position for the flow required.

IMPORTANT: No heat pump should be connected to the supply and return piping until the water system has been cleaned and flushed completely. See “Cleaning and Flushing the Water System” on page 23.

Check for proper water balance by measuring the differential temperature reading across the water connections. To ensure proper water flow, it should be between 10°F and 14°F for heat pumps in the cooling mode.

Condensate Drain Piping

Condensate lines on vertical units are internally trapped. A flush-mounted condensate drain connection is provided on the outside of the cabinet. Condensate piping can be PVC, steel or copper. PVC typically eliminates the need to insulate the pipe to prevent sweating. Do

not locate any point in the drain system above the drain connection of any unit.

The condensate piping system must be vented at its highest point. Refer to local codes for the correct condensate piping to drains.

Figure 9: Vented PVC Drain Piping By Others

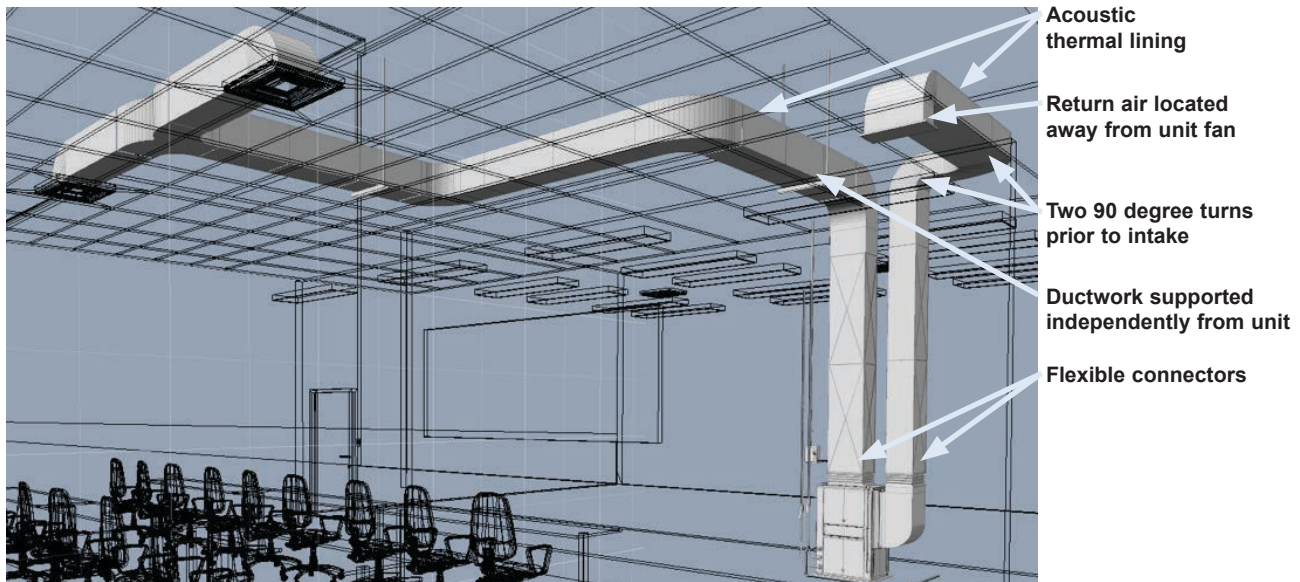


Ductwork and Sound Attenuation

Vertical unit discharge ductwork should include a non-insulated transition from the unit connection to a flexible connector at the full duct size. It should also include a short run of duct and an elbow internally lined with insulation but without turning vanes. The main duct may tee into branch circuits with discharge diffusers. Ductwork should conform to industry standards. See Figure 10 below and “Discharge Duct Sizing Considerations” on page 12.

Ductwork should be lined with an acoustic, thermal insulation that is a minimum of ½ inch thick. For sensitive installations, use 1-inch insulation a minimum of five to 10 feet prior to each diffuser. For applications that are especially acoustically sensitive, consider an acoustic kit that includes additional unit lining and dampening material beneath the entire unit.

Figure 10: ASHRAE AND SMACNA Suggested Supply and Return Air Ducting



Discharge Duct Sizing Considerations

The return air may be ducted or non-ducted. If it is non-ducted, provisions must be made for return air to freely enter the space, through a louvered door for example. A sound baffle may be needed on the door to attenuate noise from the unit. For non-ducted applications, a clearance in front of the unit of at least 12" is suggested to provide even air distribution across the air coil.

Return air ductwork, where used, should be internally lined with acoustic insulation and include a flexible connector at the unit. Sound attenuation is particularly critical at the unit return. The filter section on all units is supplied with a bracket to accommodate return ductwork.

Discharge Duct Sizing Considerations

In order to generate full airflow on forward curve fans like those used in HydroBank units, it is essential that the discharge duct have approximately 2.5 fan diameters of straight duct to develop full airflow. This duct should be free of turns, tees, sudden expansions or contractions, etc. Failure to provide this transition ductwork can significantly reduce the maximum flow that the blower can deliver. See Figure 11 to the right.

AMCA Standard 210 specifies an outlet duct that is not greater than 107.5% nor less than 87.5% of the fan outlet area. It also requires that the slope of the transition elements not be greater than 15% for converging elements, or greater than 7% for diverging elements.

Suggested discharge ductwork sizing for HydroBank units based on these recommendations is provided in Table 1 and Table 2 to the right.

All Mammoth units are tested for airflow as part of our ISO/ARI certification program. It is possible to have airflow that is above or below design requirements for many reasons. The first step in evaluating and correcting air flow rates is to compare the catalog fan performance to the measured external static pressures and airflow.

Possible corrections for too much airflow include:

- Change the blower motor to a lower speed.
- Add static to the system. A thicker filter is an easy option.

Possible corrections for not enough airflow include:

- Change the blower motor to a higher speed.
- Remove static from the system by replacing dirty filters.
- Check the ductwork for common design or installation problems.

More detailed information including suggestions for correcting airflow problems can be found in the AMCA Fan Application Manual.

Figure 11: Controlled diffusion and establishment of a uniform velocity profile in a straight length of outlet duct

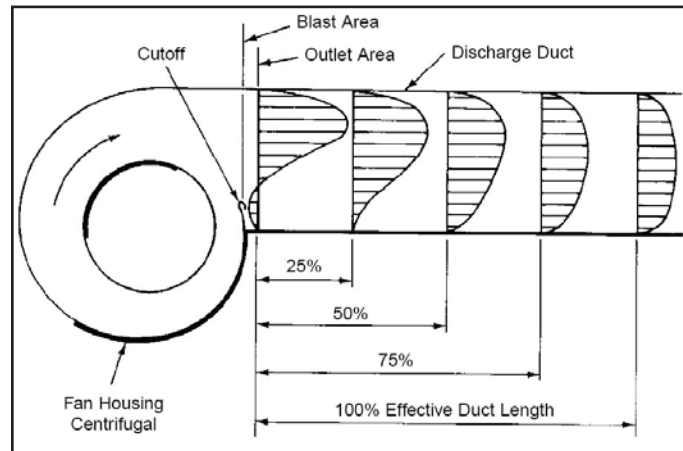


Table 1: Horizontal unit discharge duct sizing - inches

Unit Size	Minimum Straight Discharge	Maximum Duct		Minimum Duct	
		Width	Height	Width	Height
006 - 012	12.5	8.6	9.7	7.0	7.9
015 - 024	22.5	10.5	14.0	8.5	11.4
030	25.0	10.5	14.0	8.5	11.4
036 - 042	25.0	11.8	17.2	9.6	14.0
048 - 070	25.0	14.5	17.2	11.8	14.0

Table 2: Vertical unit discharge duct sizing - inches

Unit Size	Minimum Straight Discharge	Maximum Duct		Minimum Duct	
		Width	Height	Width	Height
006 - 012	12.5	9.7	9.7	7.9	7.9
015 - 024	22.5	15.1	15.1	12.3	12.3
030 - 042	25.0	15.1	15.1	12.3	12.3
048 - 070	25.0	19.4	17.2	15.8	14.0

Ventilation Air Considerations

Outside air may be required for ventilation. Refer to local codes. The temperature of the ventilation air must be controlled so that the mixture of outside air and return air entering the unit is within application limits. It is recommended that the ventilation air inlet be closed during unoccupied periods (i.e. night setback).

The ventilation air system is typically a separate building subsystem with its own distribution ductwork. Simple introduction of the outside air into each return air plenum chamber is recommended, reasonably close to the unit air inlet. Do not duct outside air directly to the unit inlet. Provide sufficient distance for the thorough mixing of outside and return air.

Electrical Connections

All field installed wiring must comply with all local and national electrical codes. See “Electrical Data” starting on page 34 for applicable fuse or breaker sizes. Consult the wiring diagram provided with your unit for the field connections required.



WARNING! Electric shock and moving equipment hazard. Can cause severe injury or death. Lock and tag out all electric power during installation.

Wiring to the unit is routed through the electrical knockouts in the front corner of the unit. See Figure 12 and Figure 13. For detailed information on knockout locations and sizes, see the dimensional drawings provided with your unit submittal package.

Figure 12: Horizontal Unit Electrical Connections

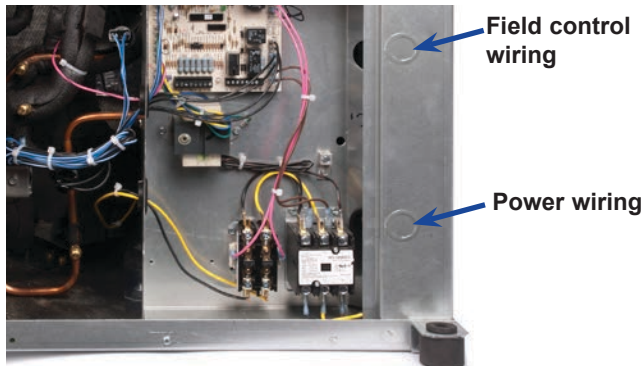
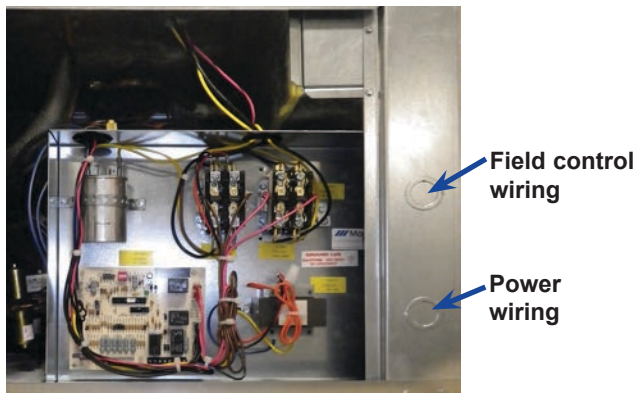


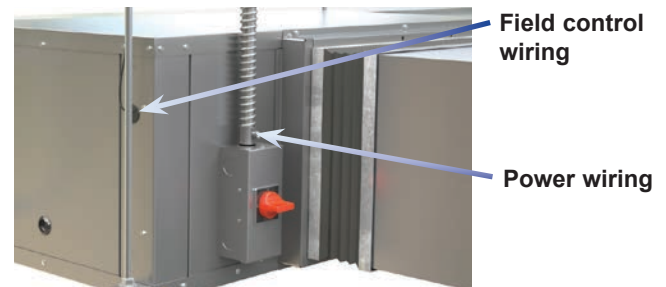
Figure 13: Vertical Unit Electrical Connections



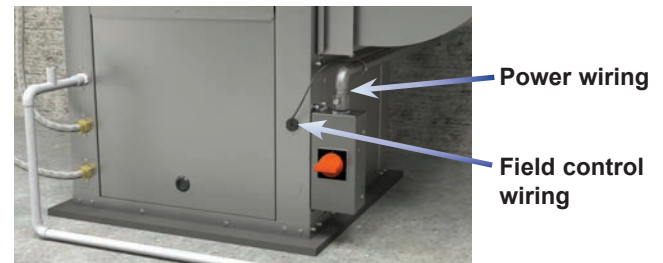
On units equipped with the non-fused disconnect option, power wiring is brought in through the knockout in the top of the junction box. See Figure 14.

Figure 14: Non-Fused Disconnect Electrical Connections

Horizontal Unit



Vertical Unit



Operating Voltage

Incoming power supply must comply with the data in Table 3. Unit operation outside of the minimum or maximum range is not recommended and will result in premature component failure.

IMPORTANT! Units operating with over- or under-voltage conditions for extended periods of time will experience premature component failure. Three-phase system imbalance should not exceed 2%.

Table 3: Operating voltages

	Minimum	Maximum
208-230/60/3	197 volts	253 volts
460/60/3	414 volts	506 volts
380-415/50/3	342 volts	418 volts
575/60/3	515 volts	632 volts

Optional Water Side Economizer Piping and Control

The waterside economizer option (WSE) allows pre-cooling of the entering air to take advantage of cool loop fluid and to reduce compressor operation during cool weather. Water lines and condensate drain lines are attached to the unit as shown in Figure 16. All water lines and valves should be insulated to prevent condensation. The condensate drain for the WSE coil must be trapped (the unit drain is internally trapped).

Each waterside economizer includes a water-to-air coil, a 3-way water diverting valve, an aquastat (water temperature switch), a relay and interconnecting wiring to the unit controls box. The aquastat is factory set at 65°F. It is field adjustable from 45° to 75°F. See Figure 16 for the location of the access panel to adjust the switch.

Control Sequence with One-Stage Thermostat

On a call for cooling, the 3-way diverting valve opens for economizer cooling if the entering water temperature

is below the set point of the aquastat. If it is above the aquastat set point, the compressor is automatically energized for mechanical cooling.

Control Sequence with Two-Stage Thermostat

On a call from the thermostat for stage-one cooling, the 3-way diverting valve opens for economizer cooling if the entering water temperature is below the set point of the aquastat. If it is above the aquastat set point, the compressor is energized for mechanical cooling.

On a call for stage-two cooling, the compressor starts for simultaneous compressor and economizer cooling. If the entering water temperature rises above the aquastat set point, the 3-way valve closes to stop economizer cooling and the compressor remains energized for mechanical cooling.

Figure 15: Water Side Economizer Wiring Diagram

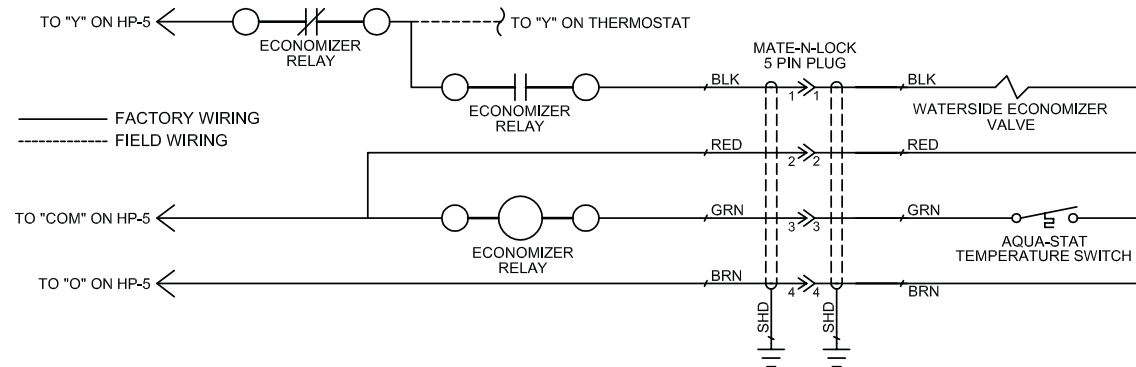
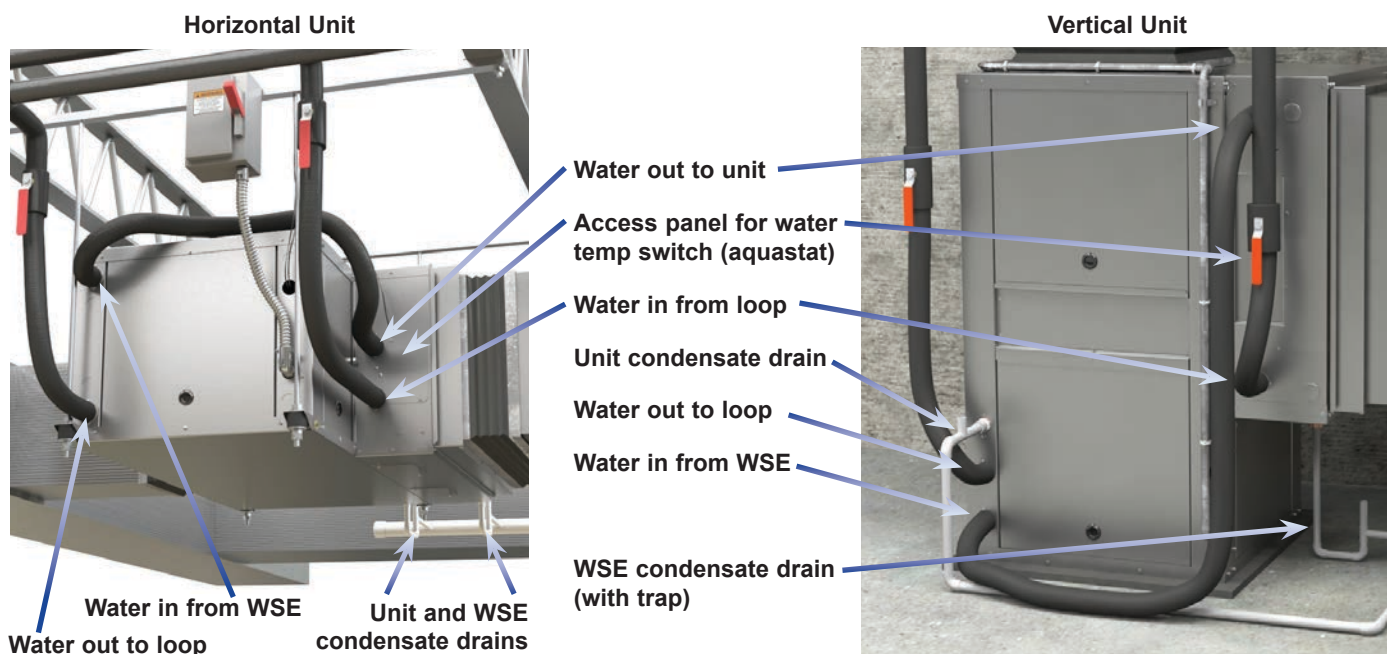


Figure 16: Water Side Economizer Piping

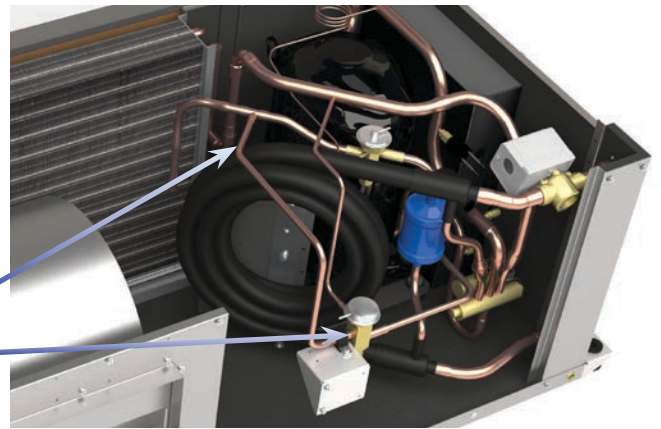


Hot Gas Bypass Option

Hot gas bypass prevents frosting of the evaporator coil during low-load conditions by keeping the compressor more fully-loaded. Hot, high-pressure refrigerant gas is diverted to the low-pressure suction side to help stabilize the system balance point. This option includes a hot gas bypass valve.

Hot gas bypass to low-pressure line

Hot gas bypass valve



Hot Gas Reheat Option

Hot gas reheat is the ideal solution to prevent over-cooling of the occupied space when the unit is in dehumidification mode. Hot gas is used to reheat saturated air coming off the cooling coil without using an external heat source.

NOTE: This option requires that a field-supplied humidistat be connected to the R and H terminals on the terminal block located inside the control panel. See the wiring diagram below.

Hot gas reheat coil

Hot gas reheat valve

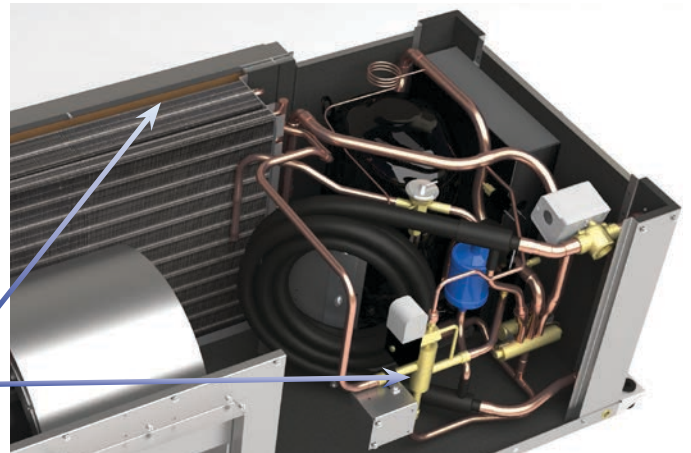
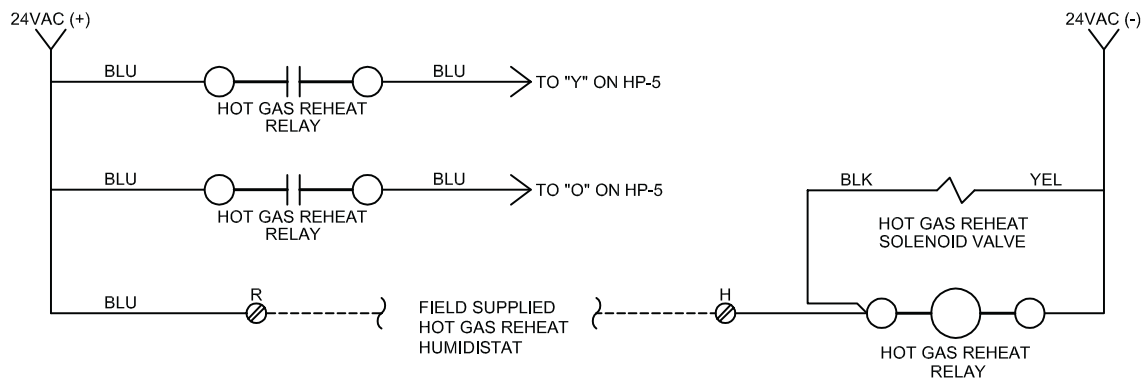


Figure 17: Hot Gas Reheat Wiring



Motorized Shutoff Valve Option

The motorized valve option is typically used in systems that employ VFDs on the condenser water pumps. When the space temperature set point is satisfied, the unit shuts down and the valve closes. Pump power is thus greatly reduced at reduced flows, resulting in significant energy savings.

The motorized valve shuts off the water flow through the unit when the compressor is off. The valve is a normally open, power-close type and will open in the event of power loss.

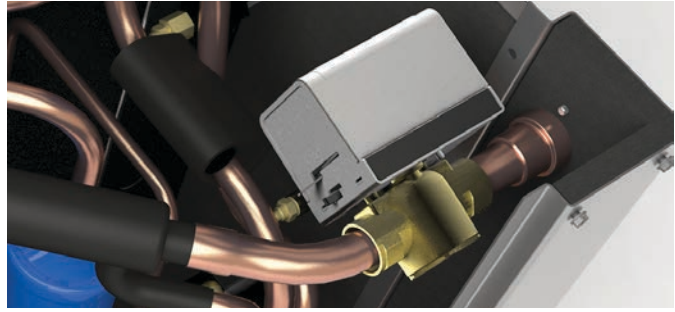


Figure 18: Motorized Valve Option

HP-5 Microprocessor Control

Features

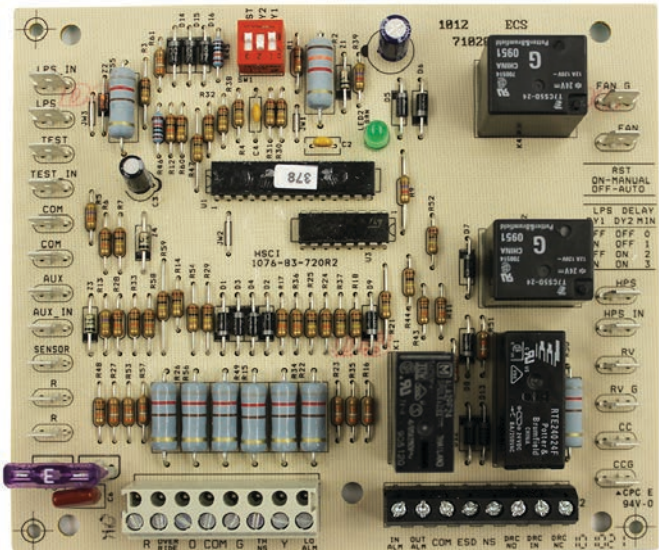
- Low and high voltage protection.
- Check microprocessor at startup – self-diagnostic
- Random start time delay from 5 to 35 seconds
- Compressor anti-short cycle protection for 300 seconds (5 minutes)
- Compressor, fan and reversing valve control
- Condensate overflow protection
- Compressor lockout with selectable intelligent/manual reset
- LED status on the board
- Lockout alarm signal to an LED in the wall thermostat in the event of a safety circuit fault
- Fan interlock to automatically energize the fan whenever the compressor is on
- Board operable on 50 and 60 cycle power
- Emergency shutdown from a field-supplied signal
- Unoccupied (night setback and night setup) mode from a field-supplied signal.
- Dry contact alarm signal for connection of a fault signal to a DDC controller.
- Auxiliary dry contact for tie-in of a motorized valve when the compressor is on (or optional compressor status)
- Night heating or cooling operation from the wall thermostat (compatible Mammoth thermostat required)
- Override of the unoccupied mode from the thermostat for 2 hours (compatible Mammoth thermostat required)

- Low and high pressure compressor protection
- Low pressure bypass with 0, 1, 2 and 3 minute selections.

Operation

INITIAL POWER-UP: When power is applied to the controller from unit's 24-volt transformer, a "green" LED will be illuminated and a 120 second time delay will occur before the fan, reversing valve and compressor are able to operate. The controller will perform a self-diagnostic and voltage check.

Figure 19: HP-5 Microprocessor Board



LOSS OF POWER: On a loss of 24-volt power to the board, all the outputs are de-activated. On return of power, a 120 second time delay will occur before the fan, reversing valve and compressor are able to operate. After 120 seconds, the fan, reversing valve and compressor are able to operate after a short time delay.

RANDOM START: A 5 to 35 second time delay of fan, reversing valve and compressor operation will occur each time the unit comes off shutdown mode, unoccupied mode and low/high voltage mode. The random start time varies each time it is activated; for example, the time delay may be 5 seconds, then 12, then 30, then 17, then 32, then 6, etc.

Note: The following descriptions assume Initial Power-up and Random Start functions have occurred.

FAN OPERATION: On a call for fan operation from the wall thermostat “fan on” switch or from a call for compressor operation, fan operation is delayed for 2 seconds.

REVERSING VALVE: On a call for cooling from the wall thermostat, the reversing valve is energized after 4 seconds. Once the cooling demand is satisfied, the reversing valve is held on for 4 seconds before it is de-energized.

COMPRESSOR OPERATION: On a call for cooling or heating from the wall thermostat, the compressor is energized from the compressor output terminal after 6 seconds. Once the call for cooling or heating is satisfied, the compressor shuts off immediately. At that time, a 300 second (5 minute) timer begins to prevent the compressor from re-starting even though the wall thermostat may again call for cooling or heating. During this 300 second interval, the compressor will not be allowed to restart. After the 300 second time delay elapses, the compressor is allowed to start if the wall thermostat calls for cooling or heating.

FAN INTERLOCK OPERATION: When compressor operation is required, the fan is automatically enabled 4 seconds before the compressor, even if the wall thermostat is not calling for fan operation. This makes sure the fan will be on whenever the compressor is on.

SAFETY CIRCUIT OPERATION: The unit has up to 4 safety circuits to prevent the compressor from operating during abnormal conditions.

- **High Pressure Switch:** If the refrigerant pressure exceeds the high pressure set-point, the high pressure switch opens immediately and the unit goes into the lockout mode
- **Low Pressure Switch:** If the refrigerant pressure falls below the low pressure set-point, the low pressure switch closes immediately and the unit goes into the lockout mode after the amount of low pressure bypass has been satisfied.
- **Optional Freezestat Switch:** If the leaving fluid temperature falls to 32°F, the freezestat switch opens. After 10 seconds, the unit goes into lockout mode.

- **Condensate Overflow Protection:** If the drain pan sensor comes in contact with moisture for more than 30 seconds, the unit goes into lockout mode.

LED STATUS:

- **ON** Normal operating mode
- **1 Flash** High pressure fault
- **2 Flashes** Emergency shutdown mode
- **3 Flashes** Freezestat switch
- **4 Flashes** Condensate overflow fault
- **5 Flashes** Low voltage fault
- **6 Flashes** High voltage fault
- **7 Flashes** Low pressure fault

LOCKOUT MODE: Lockout mode will occur if any of the safety circuits are activated. In this condition the compressor is de-energized, but the fan operates if the wall thermostat is calling for cooling or heating. The two lockout alarm circuits are also enabled.

LOW AND HIGH VOLTAGE PROTECTION: If voltage conditions are good, the unit performs a self-diagnostic check for faults. If no faults are identified, the “green” LED comes on with no flashes. If the supply voltage falls below the minimum or above the maximum, the reversing valve, fan and compressor are de-energized. LED lights will indicate the fault. Once the voltage falls within an acceptable range, the unit will restart without requiring a reset. All time delays required for start-up of the fan, compressor and reversing valve will take place before the unit is re-started. The low voltage cut-out is 21.6 VAC and the cut-in is 24.0 VAC. The high voltage cut-out is 34.0 VAC and the cut-in is 29.7 VAC. These high and low voltages are monitored at terminals “R” and “COM”.

LOCKOUT ALARM (CIRCUIT) SIGNAL: This is the first lockout alarm circuit. In the lockout mode, the circuit provides a 24-volt power (+) signal at the “LO ALM” terminal of the terminal block which is wired to the LED on the wall thermostat to indicate a lockout condition.

DRY CONTACTS LOCKOUT ALARM (CIRCUIT) SIGNAL: This is the second lockout alarm circuit. In the lockout mode, this circuit provides a signal at the terminal block. The signal is a set of normally open contacts at terminals “IN ALM” and “OUT ALM” of the unit terminal strip. The contacts close in the lockout mode, allowing connection of a remote alarm.

RESET OF A LOCKOUT: The controller can be selected to manual or intelligent reset of a lockout mode through an on-board dip switch labeled as “RST”. When a manual reset is selected, the unit stays in lockout until it is manually reset by interrupting power or by removing the

call for mechanical heating or cooling. Intelligent reset automatically terminates the lockout mode 5 minutes after a lockout condition occurs. The purpose of intelligent reset is to allow the unit to attempt to reset itself if the condition that caused the original lockout corrects itself. After 3 attempts in a 6000 second (100 minute) period after the first lockout, the intelligent reset feature is terminated and the unit stays in lockout until the unit is manually reset. The number of reset attempts is limited to protect the unit from severe damage.

OVERRIDE: The override feature is available with the wall thermostat and is activated by the push button on the face of the wall thermostat (see Figure 3). When pushed, the unit will switch back to its normal occupied temperature set points on the wall thermostat for 2 hours. After 2 hours, the unit will resume its unoccupied mode operation until the unoccupied mode signal is removed from terminals "COM" and "NS". The push button is only operable when the unit is in the unoccupied mode.

EMERGENCY SHUTDOWN MODE: Emergency shutdown allows the unit to be made inoperable via a remote signal. The emergency shutdown mode can be activated in two ways:

- By closing the circuit between terminals "COM" and "ESD" via a field supplied set of contacts (see Figure 4).
- By supplying 24 volts to terminals "COM" and "ESD".

In shutdown mode, the reversing valve, fan and compressor are inoperable, the lockout alarm circuits are activated and the green LED flashes repeatedly 2 times (quick ON and one long OFF). The unit does not need to be reset. The signal at terminals "COM" and "ESD" can be "daisy-chained" between many units. When the signal to terminals "COM" and "ESO" is removed, the random start timing function is activated.

AUXILIARY DRY CONTACTS: A pair of normally open contacts at terminals "DRC IN" and "DRC OUT" shall close and a pair of normally closed contacts at terminals "DRC IN" and "DRC OUT" shall open when the compressor is energized. This will allow connection of 24-volt power to the normally closed contacts to supply power to a normally open (powered close) motorized valve when the compressor is on.

TEST PIN JUMPER: An on-board pair of male terminals provides for an optional mode of operation which defeats both forms of compressor time delays. If a hard-wired jumper is placed across the "TEST" and "TEST IN" terminals, the random start time delay and the compressor's five minutes of anti-short cycle time delay will be ignored. However, the two, four and six second

time delays on the fan, reversing valve and compressor remain in place.

LOW PRESSURE BYPASS: The dip switches labeled "DY1" and "DY2" allow for four different amounts of low pressure switch bypass: zero, one, two and 3 minutes. The low pressure bypass timer logic occurs anytime the board senses a low pressure switch fault.

Testing

FIELD TEST MODE: If the two "TEST" quick connect terminals are connected, there will be no random start delay, no anti-short cycle delay, and no power to delay present. The normal fan, reversing valve, and compressor on delays of two, four, and six seconds will still be present, as well as the four second reversing off delay.

FACTORY TEST MODE: The factory mode is entered by applying the correct combination of inputs to the control at power up. The factory test mode operates the control by associating control outputs with inputs. The factory test mode is automatically canceled 30 seconds after control power up and may not be run again until power is removed from the control.

- **Factory Test Mode Initiation:** The control checks the control inputs during the first 1.0 seconds after power up, looking for the factory speedup input combination. To initiate the factory test mode, at some point during the first 1.0 seconds after power up, the high pressure switch input must be active, the "SENSOR" input must have 470 kΩ connected, the two "TEST" quick-connect terminals connected, voltage source must be between 22 to 29 VAC, and all of the other inputs must be inactive.
- **Factory Test Mode Operation:** While in the factory test mode, the following combinations of inputs will result in the operation of the corresponding output conditions:
 - LED stays active.
 - "O" thermostat input active and night setback input inactive - Reversing valve output active.
 - "G" thermostat input active and emergency shutdown input inactive - Fan output active.
 - "Y" thermostat input active and high pressure switch input active - Compressor output active.
 - Thermostat night setback input active and override input inactive - Alarm output active.

Thermostat Wiring

The HP-5 microprocessor control is designed to operate with wall thermostats sold by Mammoth. It can be used with other heat pump thermostats but some features may not be available. Wiring from the thermostat is routed through an electrical knockout in the front of the unit.

See Figure 12 and Figure 13 on page 13. A removable terminal block simplifies hookup. See Figure 20. To remove it, gently pull it straight out from the control board. Thermostat connections are made as described in the following diagrams.

Figure 20: HP-5 Controller

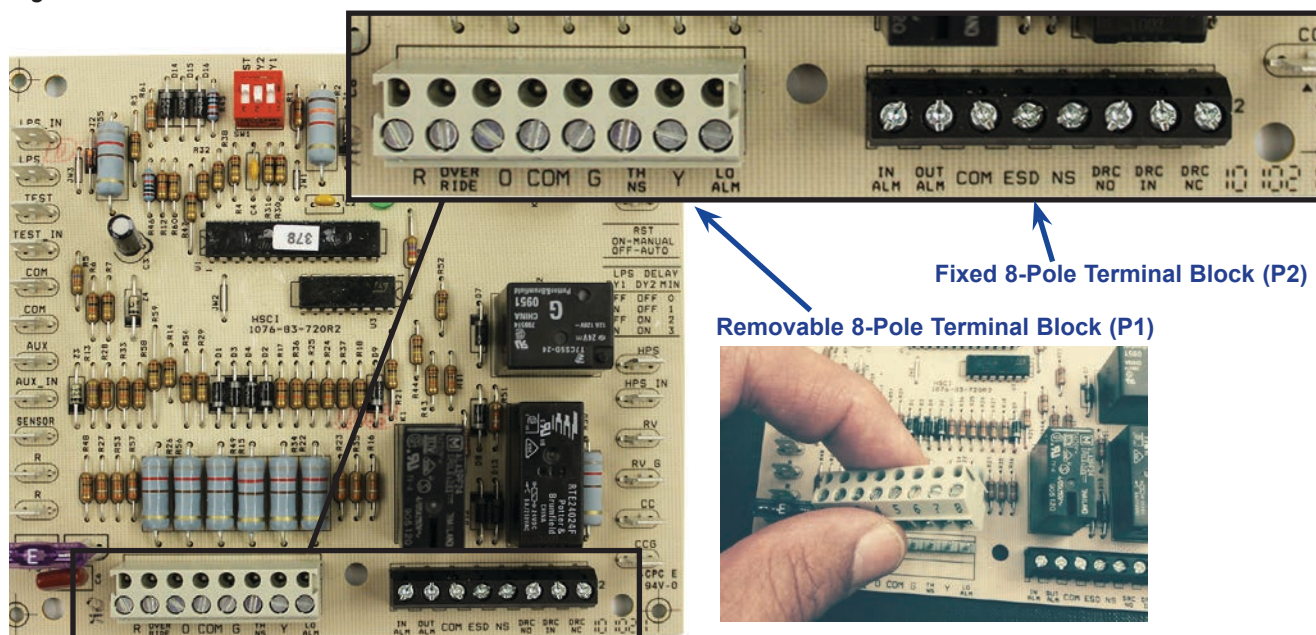


Figure 21: Thermostat Wiring With Night Setback/Night Setup and Emergency Shutdown

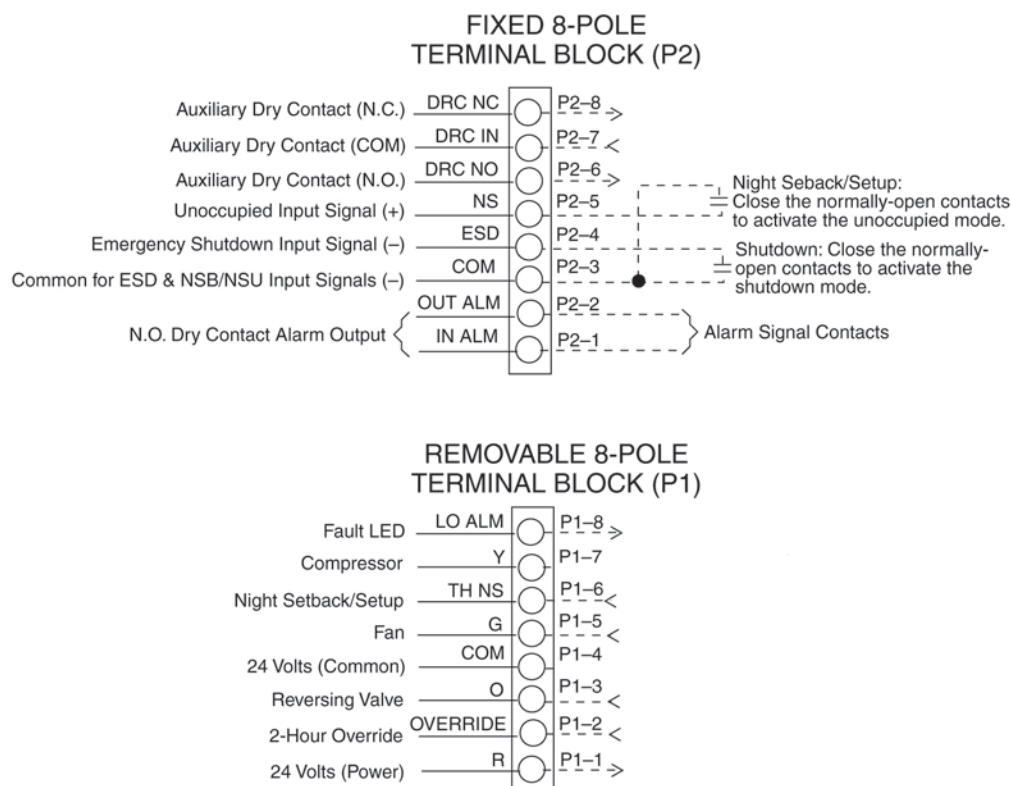


Figure 22: Thermostat Wiring With Override and Night Setback

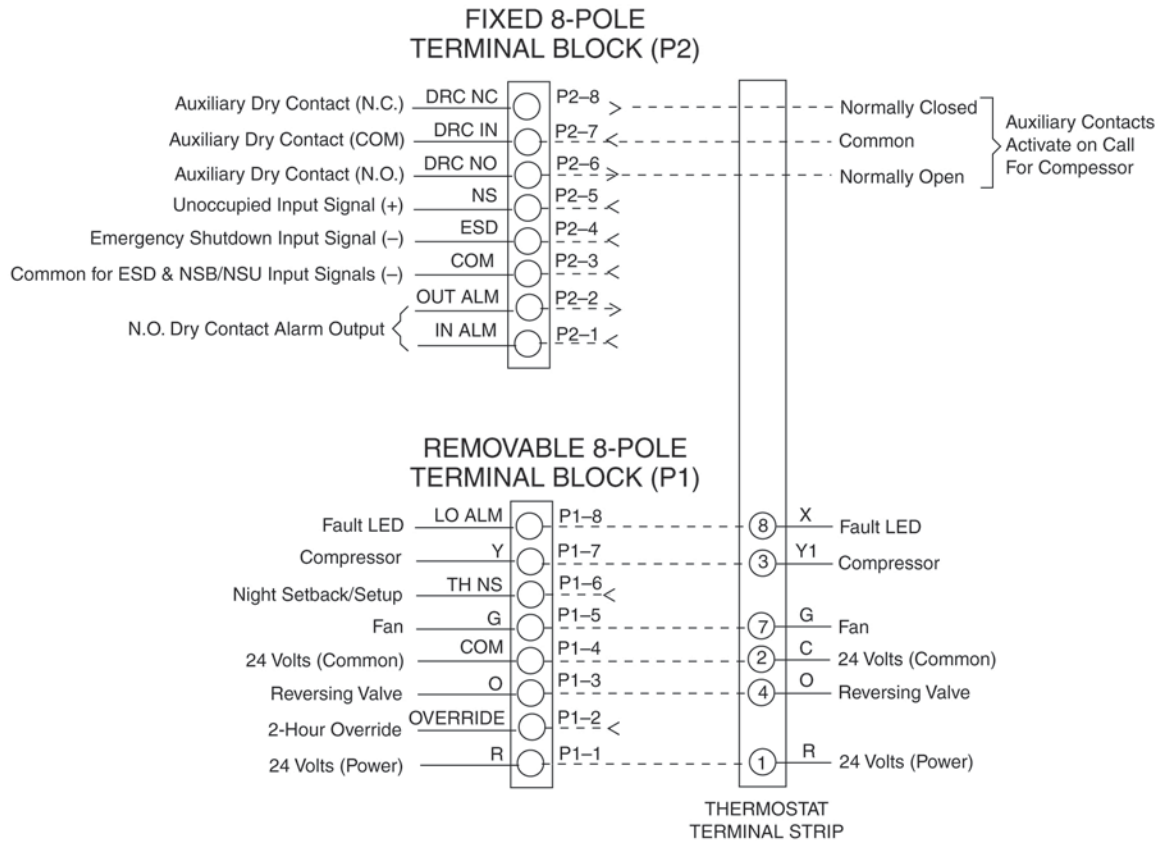


Figure 23: Thermostat Wiring - Emergency Shutdown Mode With Override

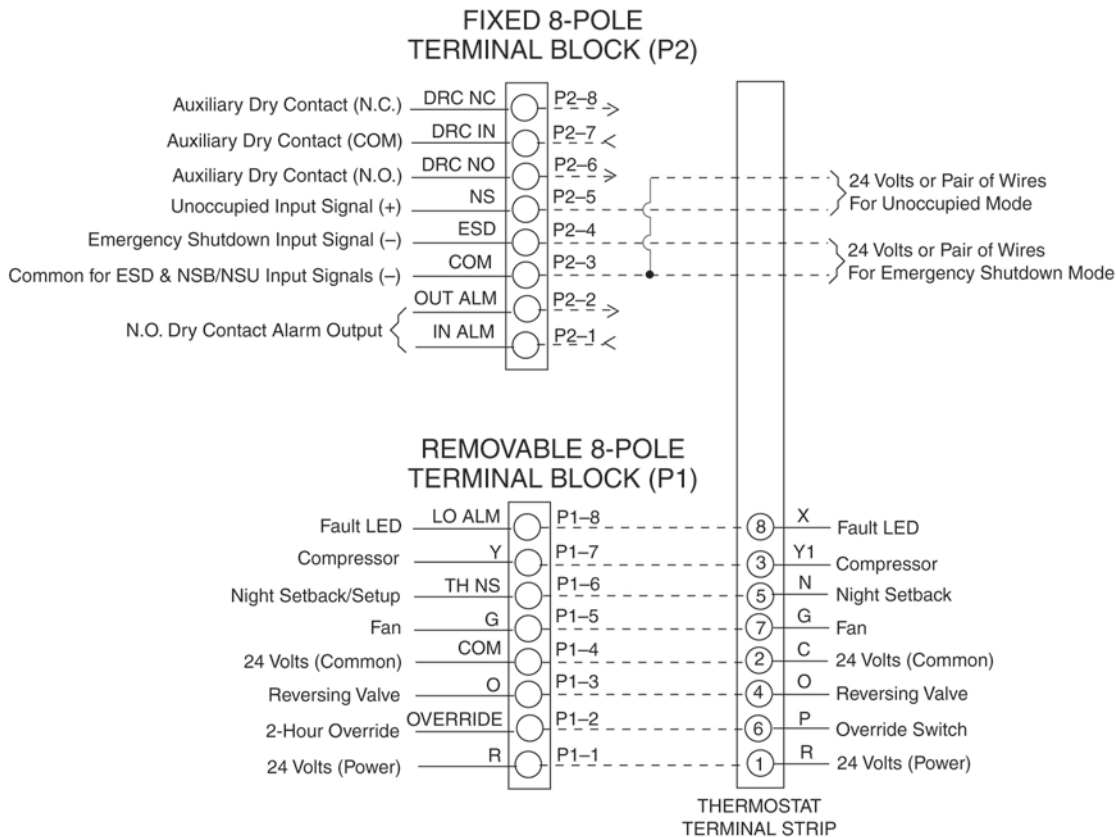
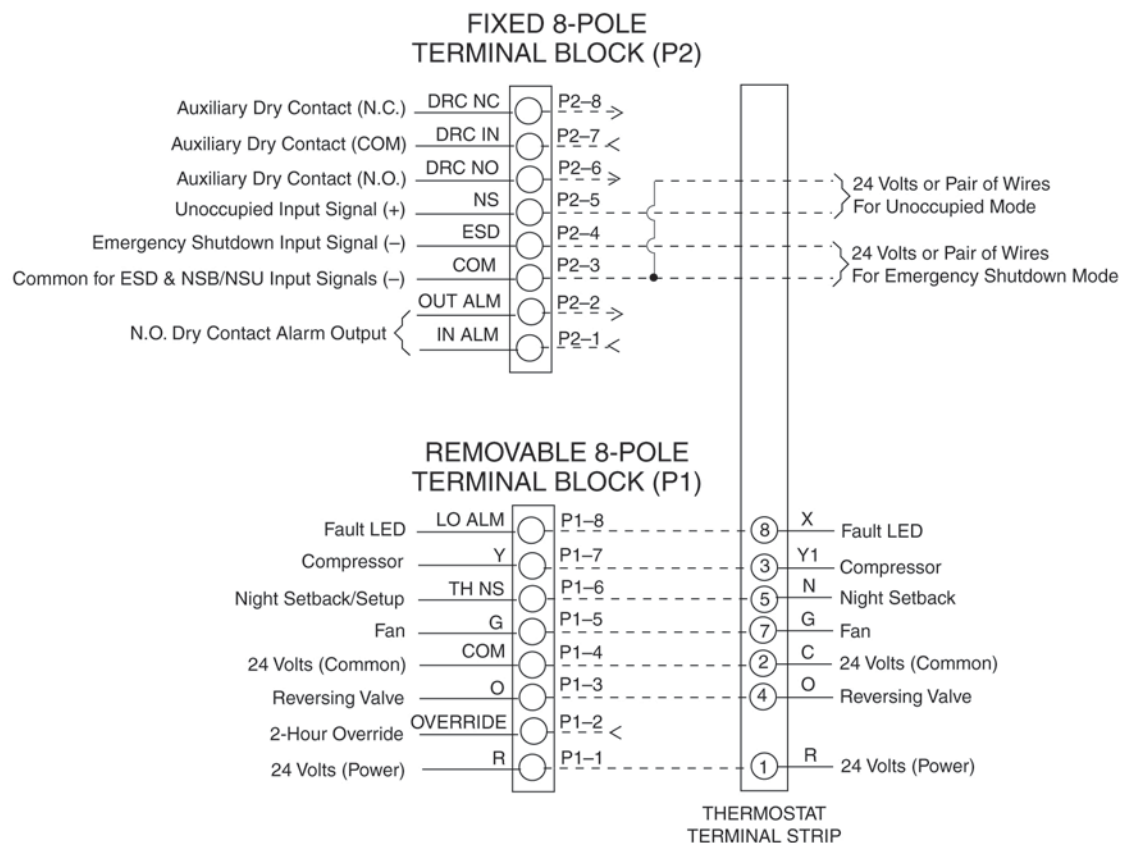


Figure 24: Thermostat Wiring - Emergency Shutdown Mode Without Override



EPiC™ DDC Controls

As an option, Mammoth offers factory-programmed and unit-mounted EPiC DDC controllers for precise unit operation. They are factory programmed per the application, and have a 16-bit processor with 1MB Flash RAM and 4MB of battery-backed RAM.

The control programs, hand-held human-machine interface (HMI) files and editable set-points are stored on Flash RAM at the time of download or upon manual archive initiation.

In the event of a battery-backed memory loss, the program, HMI and archived set-points are refreshed from the archived data in Flash RAM. An on-board, battery-backed, real-time clock is included to allow for stand-alone operation scheduling.

The controllers include LED indicators for power, run, processor error for each control output, Building Management System (BMS) communication transmit, and BMS communication receive.

EPiC controllers are capable of BMS network communication using either BACnet MSTP, Modbus RTU, or JCI N2 without an external gateway device from 9.6k to 76.8k Baud. They conform to BACnet Advanced Application Controller (B-ACC) Standard Device Profile as defined in ANSI/ASHRAE Standard 135-2012 (BACnet) Annex L, Protocol Revision 9.

EPiC controllers are also capable of BMS network communication using LonWorks (LonTalk) protocol with an optional LonCard to only include the required neuron chip. There are no requirements for LonCard programming.

A sensor/HMI network port allows 5 remote-mounted wall sensors and an HMI to be connected at the same time.

Wiring diagrams for these controllers are provided on pages page 46 and page 47.

Inputs:

- Supply (discharge) air temperature sensor
- Entering source water temperature sensor
- Leaving source water temperature sensor
- Emergency shutdown dry contact
- Remote start/stop dry contact
- Compressor alarm dry contact
- Compressor lockout dry contact
- Dirty filter dry contact
- Fan proof dry contact

- A sensor/HMI networked, wall-mounted, room/space air temperature sensor (optional room/spare air temperature/humidity sensor).

Digital Outputs:

- Supply Fan Start
- Compressor Start
- Reversing valve
- Common Alarm

Analog Outputs (EPiC 583 Controller Only):

- Start and modulate a variable-capacity compressor
- Control an optional modulating heating source
- Control an optional reheat source

For more control options, contact your Mammoth representative.

Figure 25: EPiC 560 Controller



Figure 26: EPiC 583 Controller with Analog Outputs



Cleaning and Flushing the Water System

Before water is connected to any units, the water system must be flushed clean of particulate contaminants. Supply and return hoses to each unit should be connected together during this process to ensure the entire system is properly flushed. Follow the procedures described in this section.

IMPORTANT: Performance of WSHP units relies upon a loop water supply filtered of any particulate and chemical contaminants. Before loop water is connected to the units, the water system must be flushed clean of particulate contaminants. The water system is also required to have a neutral or slightly alkaline PH balance. Failure to bring the loop water system into compliance with these requirements, verifiable by recorded documentation, will void unit warranties.

1. Bypass all water source heat pumps in the water system by connecting supply and return hoses together with all shutoff valves in the open position..
2. Fill the system at the domestic water makeup connection.
3. After filling, close all air vents.
4. Open the pressure reducing valve.
5. Check air vents in sequence to bleed off any trapped air, providing circulation through all components of the system.
6. Check and repair any leaks in the piping.
7. Start the main circulator with the pressure reducing valve open.
8. Open the drains at the lowest point(s) in the system for the initial flush and blow down, making sure domestic water fill valves are set to make up water at the same rate.
9. Check the pressure gauge at the pump suction and manually adjust the makeup to hold the same positive steady pressure both before and after opening the drain valves.
10. Flush the system for at least two hours, or longer if required, until the drain water is clear and clean.
11. Shut off the supplemental heater (if applicable) and the circulator pump.
12. Open all drains and vents to completely drain down the system.
13. Disconnect the bypasses created in Step 1 and connect the supply and return lines to all of the water source heat pumps in the system.
14. Refill the system with clean water.
15. Test the water using litmus paper for acidity and treat as required to leave the water slightly alkaline (pH 7.5 to 8.5).
16. The specified percentage of antifreeze may be added at this time. Use commercial grade antifreeze designed for HVAC systems only. Do not use automotive grade antifreeze.

IMPORTANT: Once the system has been filled with clean water and antifreeze (if used), precaution should be taken to protect the system from dirty water conditions. Dirty water will result in system-wide performance degradation and solids may clog valves, strainers, flow regulators, etc. Additionally, the heat exchangers may become clogged which reduces compressor service life and can cause premature failure.

17. Supply power to all motors and start the circulation pumps.
18. After full flow has been established through all components, including the heat exchanger (regardless of season), and after air has been vented and loop temperatures stabilized, each of the units will be ready for check, test, startup, and water balancing.

Startup

Prior to Startup

Before unit startup, please check the following. Switch off the main power to the unit before beginning.



WARNING! Electric shock and moving equipment hazard. Can cause severe injury or death. Lock and tag out all electric power before carrying out this procedure. More than one disconnect may be required to de-energize the unit.

- Inspect and tighten as necessary all electrical terminals. They are located in the control panel inside the front of the unit.
- Verify that the main power supply is connected to the unit disconnect and that electrical power will be available to run the unit when it is switched on.
- Check that drain lines are connected to the condensate drain connections. See “Condensate Drain Piping” on page 9 for horizontal units and “Condensate Drain Piping” on page 11 for vertical units.
- Make sure that the duct system is complete enough to allow for operation.
- Make sure all air filters have been installed.

Startup

Switch on the main power to the unit. Then carry out the following procedures.

1. Open all valves to the full-open position and turn on power to the heat pump.
2. Set the room temperature sensor for “Fan Only” operation by selecting “Off” at the system switch and “On” at the fan switch. If “Auto” fan operation is selected, the fan will cycle with the compressor.
3. Check for proper air delivery.
4. HydroBank MS horizontal and vertical units have time delays which help protect the compressors against short cycling. In the cooling mode, after a few minutes of operation, check the discharge grilles for cool air delivery.
5. Measure the temperature difference between entering and leaving water. It should be approximately 1½ times greater than the heating mode temperature difference (see Step 6).

6. In the heating mode, measure the temperature difference between entering and leaving air and entering and leaving water.
 - With entering water of 60°F to 80°F, leaving water should be 6°F to 12°F cooler.
 - The air temperature rise through the unit should not exceed 35°F.
 - If the leaving water temperature falls below 35°F, adjust water flow to the unit to >3 gpm/ton to avoid freeze damage to the unit.
7. Fill the condensate trap with water to ensure that negative pressure does not pull drain gases into the unit.
8. Check the elevation and cleanliness of the condensate line. If the air is too dry for sufficient dehumidification, slowly pour enough water into the condensate pan to ensure proper drainage.
9. If the unit does not operate, check the following points:
 - Is supply voltage to the units compatible?
 - If the unit operates but stops after a brief period, check the following.
 - Is there proper airflow? Check for dirty filter, incorrect fan rotation or incorrect ductwork.
 - Is there proper water flow rate within temperature limits? Check water balancing; back flush unit if dirt clogged.
 - See the troubleshooting guide on page 21 for more tips.

Final System Check

1. Verify that controller read out values are equal to actual gauge or temperature readings, as applicable.
2. Install all refrigeration fitting caps, etc., that were removed during the startup procedure.
3. Check the refrigeration system for leaks.
4. Clean up all debris.

General Maintenance

Normal maintenance on any HydroBank MS unit includes but may not be limited to the following.

Air filter changes

Air filters must be replaced a minimum of two times per year. A good standard to follow is at the beginning of the cooling season and the beginning of the heating season. In certain environments, more frequent filter changes may be required.

For new installations, it is recommended that the air filters be checked every 60 days and changed as required until a regular interval can be established.

The filter is changed by sliding it out of the filter rack as shown in Figure 27. On units equipped with the four-sided filter rack option, the filter door pivots open for easy filter removal and replacement.

Figure 27: Filter Removal

Standard Filter Rack



Four-Sided Filter Rack



Dirty Filter Switch Option

The dirty filter switch option is designed to inform maintenance personnel when it is time to change filters. The switch senses the pressure drop across the filter.

On units equipped with Mammoth EPiC controls, a warning will be indicated when filters need changing. If the filters are not changed, the EPiC control will go into

an alarm status and the unit will shut down. The alarm must be cleared before the switch will reset.

Condensate drain

The condensate drain and drain pan should be checked on an annual basis to verify positive drainage and cleaned or flushed as necessary.

Electrical

Check the tightness of all electrical terminals twice each year. Retighten as needed.



WARNING! Loose electrical terminals can lead to erratic unit operation and arcing which may cause fires.



WARNING! Electric shock and moving equipment hazard. Can cause severe injury or death. Lock and tag out all electric power before carrying out these procedures. More than one disconnect may be required to de-energize the unit.

Data recording

Recording current draw of blower motors at regular intervals is recommended to verify their condition. Recording differences in water temperature and air temperature at regular intervals can help identify any performance degradation. Annual comparison of the data will aid in determining the overall condition and operation of the unit.

Nuisance trips and/or lockouts

Occasional trips and/or lockouts are generally caused by water or airflow restrictions. When a trip or lockout occurs, check the water flow rate, incoming water temperature, airflow rates and incoming air temperature. Take corrective action necessary to enable unit operation. See the troubleshooting guide on page 21 for more tips.

Parts and Service Support

Mammoth brand products are serviced by Authorized Service Providers. For service support, contact your Mammoth representative. Parts for Mammoth brand products are also available by contacting your local representative. For assistance locating your Mammoth representative, visit www.mammoth-inc.com.

Troubleshooting

Charts in this section provide general guidelines for troubleshooting problems with your unit. For additional help, contact your local Mammoth representative. For

assistance locating your Mammoth representative, visit www.mammoth-inc.com.

Table 4: Refrigeration System Troubleshooting

Symptom	Head Pressure	Suction Pressure	Compressor Amp Draw	Super Heat	Subcooling	Air Temp Differential	Water Loop Temp Differential	Safety Lockout
Undercharged system	Low	Low	Low	High	Low	Low	Low	Low Pressure
Overcharged system	High	High or Normal	High	Normal	High	Normal	Normal	High Pressure
Low air flow in cooling	Normal	Low	Low or Normal	Low or Normal	Normal	High	Low or Normal	Low Temp
Low water flow in cooling	High	High or Normal	High	High or Normal	Normal	Normal or Low	High	High Pressure
High air flow in cooling	Normal or Low	High	Normal	High	Low	Low	Normal	High Pressure or No Lockout
High water flow in cooling	Low	Normal	Low	Normal	Normal	Normal	Low	Low Temp or No Lockout
TVX restricted	High	Low	Normal or low	High	High	Low	Low	High Pressure

Table 5: Performance Troubleshooting

Problem	Heating	Cooling	Possible Cause	Solution
Insufficient capacity	X	X	Dirty air filter	Replace or clean.
	X	X	Low refrigerant charge	Recover refrigerant and re-charge to nameplate.
Not cooling or heating properly	X	X	Reduced or no air flow	Check for dirty air filter; clean or replace. Check fan motor operation, airflow restrictions.
	X	X	Low refrigerant charge	Recover refrigerant and re-charge to nameplate.
	X	X	Low water flow	Adjust to proper water flow rate
	X	X	Leaky duct work	Check supply and return air temperatures at the unit and at distant duct registers. If significantly different, check for duct leaks.
Unit doesn't operate in cooling	X	X	Low refrigerant charge	Recover refrigerant and re-charge to nameplate.
	X	X	Restricted metering device	Check superheat and subcooling. Replace metering device.
		X	Defective reversing valve	Perform reversing valve touch test.
	X	X	Thermostat improperly located	Check thermostat location and for air drafts behind thermostat.
	X	X	Scaling in waterside heat exchanger	Perform scaling check and clean if necessary.
	X	X	Inlet water too hot or cold	Check inlet water temperature. Check loop system for proper operation/design.
High head pressure	X		Reduced or no air flow in heating	Check for dirty air filter; clean or replace. Check fan motor operation, airflow restrictions.
		X	Reduced or no water flow in cooling	Check pump operation or valve operation/setting. Check water flow; adjust to proper flow rate.
		X	Inlet water too hot	Check inlet water temperature. Check loop system for proper operation/design.
	X		Air temperature out of range in heating	Bring return air temp within design parameters.
		X	Scaling in waterside heat exchanger	Perform scaling check and clean if necessary.
	X	X	Unit overcharged	Check superheat and subcooling.
	X	X	Non-condensable in system	Vacuum system, reweigh in charge.
Low suction pressure	X		Reduced water flow in heating	Check pump operation or valve operation/setting. Check water flow; adjust to proper flow rate.
	X		Water temperature out of range	Bring water temp within design parameters.
		X	Reduced air flow in cooling	Check for dirty air filter; clean or replace. Check fan motor operation, airflow restrictions.
		X	Air temperature out of range	Check for too much cold vent air. Bring entering air temp within design parameters.
	X	X	Low refrigerant charge	Recover refrigerant and re-charge to nameplate.
Low discharge temp in heating	X		Too high of air flow	Check fan motor speed selection and airflow.
	X		Dirty air filter restricting air flow to space	Replace or clean.

Physical Data and Operating Limits

Table 6: Physical Data: Horizontal Units

Unit Size	006	009	012	015	019	024	030	036	042	048	060	070
Compressor Type (Qty 1)	Rotary				Reciprocating						Scroll	
Max Water Working Pressure	400 PSIG (2758 kPa)											
Blower Motor Type/Speeds	PSC/3			PSC/3 or ECM/5								
PSC Motor HP	Consult Factory			1/5	1/5	1/3	1/3	1/2	1/2	1/2	3/4	3/4
ECM Motor HP	NA			1/3	1/3	1/3	1/2	1/2	1/2	3/4	1	1
Blower Wheel Size (Dia" x W")	Consult Factory			9 x 6	9 x 6	9 x 7	10 x 7	10 x 7	10 x 7	10 x 7	10 x 10	10 x 10
Water Connection Size (FPT)	1/2"					3/4"				1"		
Coaxial Coil Volume (gal)	Consult Factory			0.09	0.25	0.17	0.25	0.43	0.43	0.54	0.64	1.09
Refrigeration Charge (oz)				33	43	43	46	59	59	74	74	88
Air Coil Dimensions (H" x W")				16 x 21	16 x 21	16 x 24	16 x 24	20 x 27	20 x 27	20 x 35.5	20 x 35.5	20 x 45
Standard 1-inch Filter (L" x W")				16 x 24	16 x 24	16 x 30	16 x 30	20 x 30	20 x 30	2-20 x 20	2-20 x 20	2-20 x 24
Optional 2-inch Filter (L" x W")				16 x 24	16 x 24	16 x 30	16 x 30	20 x 30	20 x 30	2-20 x 20	2-20 x 20	2-20 x 24
Weight - Operating (lbs)				175	202	220	223	248	252	310	318	360
With Water Side Economizer				203	230	243	240	270	275	334	340	389
With Hot Gas Reheat				181	208	226	229	258	262	321	329	373
Weight - Shipping (lbs)				205	232	252	255	293	297	365	373	422
With Water Side Economizer				233	260	275	272	315	320	389	395	451
With Hot Gas Reheat				209	236	249	246	280	285	345	351	402

Table 7: Physical Data: Vertical Units

Unit Size	006	009	012	015	019	024	030	036	040	042	048	060	070		
Compressor Type (Qty 1)	Rotary				Reciprocating							Scroll			
Max Water Working Pressure	400 PSIG (2758 kPa)														
Blower Motor Type/Speeds	PSC/3			PSC/3 or ECM/5											
PSC Motor HP	Consult Factory			1/5	1/5	1/3	1/3	1/2	1/2	1/2	1/2	3/4	3/4		
ECM Motor HP	NA			1/3	1/3	1/3	1/2	1/2	1/2	1/2	3/4	1	1		
Blower Wheel Size (Dia" x W")	Consult Factory			9 x 6	9 x 6	9 x 7	10 x 7	10 x 7	10 x 8	10 x 7	10 x 7	10 x 10	10 x 10		
Water Connection Size (FPT)	1/2"					3/4"					1"				
Coaxial Coil Volume (gal)	Consult Factory			0.09	0.25	0.17	0.25	0.43	Consult Factory			0.43	0.54	0.64	1.09
Refrigeration Charge (oz)				33	46	45	48	62				62	77	80	98
Air Coil Dimensions (H" x W")				22 x 14.5	22 x 14.5	26 x 14.5	26 x 14.5	28 x 19				28 x 19	20 x 35.5	20 x 35.5	20 x 45
Standard 1-inch Filter (L" x W")				18 x 20	18 x 20	18 x 25	18 x 25	24 x 30				24 x 30	2-15 x 30	2-15 x 30	2-20 x 30
Optional 2-inch Filter (L" x W")				18 x 22	18 x 22	18 x 25	18 x 25	24 x 30				24 x 30	2-15 x 30	2-15 x 30	2-20 x 30
Weight - Operating (lbs)				161	208	213	221	250				275	317	327	364
With Water Side Economizer				196	243	252	260	302				327	375	385	432
With Hot Gas Reheat				167	214	220	228	260				285	329	339	379
Weight - Shipping (lbs)				179	220	234	242	273				296	339	349	391
With Water Side Economizer				214	255	273	281	325				348	397	407	459
With Hot Gas Reheat				185	226	241	249	283				306	351	361	406

Table 8: Operating Limits: Water and Air Temperatures (°F)

	Standard Range		Low Temp Geothermal			Standard Range		Low Temp Geothermal	
	Cooling	Heating	Cooling	Heating		Cooling	Heating	Cooling	Heating
Minimum Water Temperature	50°F	50°F	40°F	25°F	Maximum Ambient Air Temperature	110°F	110°F	110°F	110°F
Maximum Water Temperature	110°F	90°F	110°F	90°F	Minimum Entering Air Temperature	65°F	50°F	65°F	60°F
Minimum Ambient Air Temp	50°F	50°F	50°F	50°F	Maximum Entering Air Temperature	100°F	80°F	100°F	90°F

Operating Pressures and Temperatures

Table 9: Operating Pressures and Temperatures - Horizontal Unit Sizes 015, 019, 024

Horizontal 015		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	2.8	Out of Range						73-83	262-282	4-9	2-7	5-7	17-23
	4.0							75-85	265-285	4-9	2-7	4-6	17-23
	4.8							76-86	268-288	5-10	2-7	3-5	18-24
40	2.8	127-137	182-202	18-23	14-19	15-17	20-26	91-101	282-302	5-10	2-7	7-9	20-26
	4.0	127-137	172-192	18-23	12-17	10-12	20-26	93-103	285-305	5-10	2-7	5-7	20-26
	4.8	127-137	169-189	18-23	11-16	8-10	20-26	95-105	288-308	5-10	2-7	4-6	21-27
60	2.8	134-144	244-264	10-15	16-21	14-16	20-26	128-138	309-329	5-10	2-7	9-11	26-32
	4.0	134-144	232-252	10-15	14-19	10-12	20-26	130-140	312-332	5-10	2-7	6-8	26-32
	4.8	134-144	227-247	10-15	12-17	8-10	20-26	133-143	315-335	6-11	2-7	5-7	27-33
80	2.8	142-152	324-344	8-13	17-22	13-15	18-24	164-174	342-362	7-12	2-7	10-12	31-37
	4.0	142-152	308-328	8-13	14-19	9-11	18-24	168-178	346-366	8-13	2-7	7-9	31-37
	4.8	142-152	302-322	8-13	13-18	8-10	18-24	171-181	349-369	8-13	2-7	6-8	32-38
100	2.8	147-157	429-449	8-13	19-24	12-14	17-23	Out of Range					
	4.0	147-157	408-428	8-13	16-21	9-11	17-23						
	4.8	147-157	400-420	8-13	15-20	7-9	17-23						

Horizontal 019		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	3.2	Out of Range						71-81	288-308	5-10	6-11	7-9	20-26
	4.5							73-83	291-311	5-10	5-10	5-7	20-26
	5.4							74-84	294-314	6-11	5-10	4-6	20-26
40	3.2	119-129	176-196	10-15	13-18	17-19	22-28	89-99	310-330	6-11	6-11	8-10	23-29
	4.5	119-129	167-187	10-15	11-16	12-14	22-28	90-100	313-333	6-11	5-10	6-8	23-29
	5.4	119-129	164-184	10-15	10-15	10-12	22-28	92-102	316-336	7-12	5-10	5-7	24-30
60	3.2	125-135	237-257	5-10	14-19	17-19	22-28	124-134	339-359	6-11	6-11	11-13	30-36
	4.5	125-135	225-245	5-10	12-17	12-14	22-28	127-137	342-362	7-12	5-10	8-10	30-36
	5.4	125-135	221-241	5-10	11-16	10-12	22-28	130-140	346-366	7-12	5-10	6-8	31-37
80	3.2	133-143	315-335	4-9	15-20	16-18	20-26	160-170	375-395	9-14	6-11	13-15	35-41
	4.5	133-143	299-319	4-9	13-18	11-13	20-26	163-173	379-399	10-15	5-10	9-11	36-42
	5.4	133-143	293-313	4-9	11-16	9-11	20-26	167-177	383-403	10-15	5-10	7-9	37-43
100	3.2	138-148	417-437	4-9	17-22	15-17	19-25	Out of Range					
	4.5	138-148	396-416	4-9	15-20	10-12	19-25						
	5.4	138-148	388-408	4-9	13-18	8-10	19-25						

Horizontal 024		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	4.2	Out of Range						69-79	271-291	6-11	1-6	6-8	18-24
	6.0							70-80	274-294	6-11	1-6	5-7	18-24
	7.2							72-82	276-296	7-12	1-6	4-6	19-25
40	4.2	122-132	179-199	14-19	8-13	17-19	21-27	86-96	291-311	7-12	1-6	8-10	21-27
	6.0	122-132	170-190	14-19	7-12	12-14	21-27	87-97	294-314	7-12	1-6	6-8	21-27
	7.2	122-132	167-187	14-19	6-11	10-12	21-27	89-99	297-317	8-13	1-6	4-6	22-28
60	4.2	128-138	241-261	8-13	9-14	17-19	21-27	120-130	319-339	7-12	1-6	10-12	27-33
	6.0	128-138	229-249	8-13	8-13	11-13	21-27	123-133	322-342	8-13	1-6	7-9	27-33
	7.2	128-138	225-245	8-13	7-12	10-12	21-27	125-135	325-345	9-14	1-6	6-8	28-34
80	4.2	137-147	320-340	6-11	10-15	15-17	19-25	155-165	353-373	10-15	1-6	12-14	32-38
	6.0	137-147	304-324	6-11	8-13	11-13	19-25	158-168	356-376	11-16	1-6	8-10	33-39
	7.2	137-147	298-318	6-11	7-12	9-11	19-25	161-171	360-380	12-17	1-6	7-9	33-39
100	4.2	141-151	424-444	6-11	11-16	15-17	18-24	Out of Range					
	6.0	141-151	403-423	6-11	9-14	10-12	18-24						
	7.2	141-151	395-415	6-11	8-13	8-10	18-24						

Table 10: Operating Pressures and Temperatures - Horizontal Unit Sizes 030, 036, 042

Horizontal 030		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	4.9	Out of Range						66-76	265-285	9-14	1-6	6-8	17-23
	7.0							67-77	268-288	9-14	1-6	4-6	17-23
	8.4							69-79	271-291	10-15	1-6	3-5	17-23
40	4.9	120-130	176-196	11-16	5-10	17-19	21-27	82-92	286-306	10-15	1-6	7-9	20-26
	7.0	120-130	167-187	11-16	4-9	12-14	21-27	83-93	289-309	11-16	1-6	5-7	20-26
	8.4	120-130	163-183	11-16	4-9	10-12	21-27	85-95	292-312	11-16	1-6	4-6	21-27
60	4.9	126-136	236-256	6-11	6-11	17-19	20-26	115-125	312-332	11-16	1-6	10-12	26-32
	7.0	126-136	225-245	6-11	5-10	12-14	20-26	117-127	316-336	11-16	1-6	7-9	26-32
	8.4	126-136	220-240	6-11	4-9	10-12	20-26	120-130	319-339	12-17	1-6	6-8	26-32
80	4.9	134-144	314-334	5-10	6-11	16-18	19-25	148-158	346-366	15-20	1-6	11-13	31-37
	7.0	134-144	298-318	5-10	5-10	11-13	19-25	151-161	350-370	15-20	1-6	8-10	31-37
	8.4	134-144	292-312	5-10	4-9	9-11	19-25	154-164	353-373	17-22	1-6	6-8	32-38
100	4.9	139-149	416-436	5-10	7-12	15-17	17-23	Out of Range					
	7.0	139-149	395-415	5-10	6-11	10-12	17-23						
	8.4	139-149	387-407	5-10	5-10	8-10	17-23						

Horizontal 036		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	6.3	Out of Range						67-77	264-284	11-16	3-8	6-8	17-23
	9.0							69-79	266-286	11-16	3-8	4-6	18-24
	10.8							70-80	269-289	12-17	3-8	3-5	18-24
40	6.3	122-132	175-195	9-14	4-9	16-18	21-27	83-93	284-304	12-17	3-8	7-9	20-26
	9.0	122-132	166-186	9-14	3-8	11-13	21-27	85-95	287-307	13-18	3-8	5-7	21-27
	10.8	122-132	163-183	9-14	3-8	9-11	21-27	87-97	290-310	14-19	3-8	4-6	21-27
60	6.3	128-138	236-256	5-10	5-10	15-17	21-27	117-127	310-330	13-18	3-8	9-11	26-32
	9.0	128-138	224-244	5-10	4-9	11-13	21-27	120-130	314-334	14-19	3-8	6-8	27-33
	10.8	128-138	219-239	5-10	3-8	9-11	21-27	122-132	317-337	15-20	3-8	5-7	27-33
80	6.3	137-147	313-333	4-9	5-10	14-16	19-25	151-161	344-364	18-23	3-8	10-12	31-37
	9.0	137-147	297-317	4-9	4-9	10-12	19-25	154-164	347-367	19-24	3-8	7-9	32-38
	10.8	137-147	291-311	4-9	4-9	8-10	19-25	157-167	351-371	20-25	3-8	6-8	33-39
100	6.3	141-151	414-434	4-9	6-11	13-15	18-24	Out of Range					
	9.0	141-151	394-414	4-9	5-10	9-11	18-24						
	10.8	141-151	386-406	4-9	4-9	8-10	18-24						

Horizontal 042		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	7.4	Out of Range						68-78	271-291	6-11	1-6	6-8	18-24
	10.5							70-80	274-294	6-11	1-6	4-6	18-24
	12.6							71-81	277-297	7-12	1-6	3-5	18-24
40	7.4	120-130	176-196	11-16	9-14	16-18	21-27	85-95	292-312	7-12	1-6	7-9	21-27
	10.5	120-130	167-187	11-16	7-12	11-13	21-27	87-97	295-315	7-12	1-6	5-7	21-27
	12.6	120-130	164-184	11-16	7-12	9-11	21-27	89-99	298-318	8-13	1-6	4-6	22-28
60	7.4	126-136	237-257	6-11	10-15	15-17	21-27	119-129	319-339	7-12	1-6	9-11	27-33
	10.5	126-136	225-245	6-11	8-13	10-12	21-27	122-132	323-343	8-13	1-6	7-9	27-33
	12.6	126-136	221-241	6-11	8-13	9-11	21-27	124-134	326-346	9-14	1-6	5-7	28-34
80	7.4	135-145	315-335	5-10	11-16	14-16	19-25	154-164	354-374	10-15	1-6	11-13	32-38
	10.5	135-145	299-319	5-10	9-14	10-12	19-25	157-167	357-377	11-16	1-6	8-10	32-38
	12.6	135-145	293-313	5-10	8-13	8-10	19-25	160-170	361-381	12-17	1-6	6-8	33-39
100	7.4	139-149	417-437	5-10	12-17	13-15	18-24	Out of Range					
	10.5	139-149	397-417	5-10	10-15	9-11	18-24						
	12.6	139-149	389-409	5-10	9-14	8-10	18-24						

Operating Pressures and Temperatures

Table 11: Operating Pressures and Temperatures - Horizontal Unit Sizes 048, 060, 070

Horizontal 048		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	8.4	Out of Range						68-78	275-295	7-12	2-7	6-8	18-24
	12.0							70-80	278-298	8-13	2-7	4-6	18-24
	14.4							71-81	281-301	8-13	2-7	3-5	19-25
40	8.4	120-130	177-197	13-18	9-14	16-18	22-28	85-95	296-316	8-13	2-7	7-9	21-27
	12.0	120-130	168-188	13-18	7-12	11-13	22-28	87-97	299-319	9-14	2-7	5-7	22-28
	14.4	120-130	165-185	13-18	7-12	9-11	22-28	89-99	302-322	9-14	2-7	4-6	22-28
60	8.4	126-136	239-259	7-12	10-15	16-18	21-27	119-129	323-343	9-14	2-7	9-11	27-33
	12.0	126-136	227-247	7-12	8-13	11-13	21-27	122-132	327-347	9-14	2-7	7-9	28-34
	14.4	126-136	222-242	7-12	8-13	9-11	21-27	124-134	330-350	10-15	2-7	5-7	28-34
80	8.4	135-145	317-337	5-10	10-15	14-16	19-25	154-164	358-378	12-17	2-7	11-13	33-39
	12.0	135-145	301-321	5-10	9-14	10-12	19-25	157-167	362-382	13-18	2-7	8-10	33-39
	14.4	135-145	295-315	5-10	8-13	8-10	19-25	160-170	366-386	14-19	2-7	6-8	34-40
100	8.4	139-149	420-440	5-10	12-17	14-16	18-24	Out of Range					
	12.0	139-149	399-419	5-10	10-15	9-11	18-24						
	14.4	139-149	391-411	5-10	9-14	8-10	18-24						

Horizontal 060		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	10.5	Out of Range						68-78	285-305	6-11	3-8	6-8	19-25
	15.0							69-79	288-308	7-12	3-8	4-6	20-26
	18.0							71-81	291-311	7-12	3-8	3-5	20-26
40	10.5	117-127	179-199	12-17	8-13	16-18	22-28	84-94	307-327	7-12	3-8	7-9	23-29
	15.0	117-127	170-190	12-17	7-12	11-13	22-28	86-96	310-330	8-13	3-8	5-7	23-29
	18.0	117-127	166-186	12-17	6-11	9-11	22-28	88-98	313-333	8-13	3-8	4-6	24-30
60	10.5	124-134	241-261	7-12	9-14	15-17	21-27	118-128	336-356	8-13	3-8	9-11	29-35
	15.0	124-134	229-249	7-12	8-13	11-13	21-27	121-131	339-359	8-13	3-8	7-9	30-36
	18.0	124-134	224-244	7-12	7-12	9-11	21-27	123-133	343-363	9-14	3-8	6-8	30-36
80	10.5	132-142	320-340	5-10	10-15	14-16	20-26	153-163	372-392	11-16	3-8	11-13	35-41
	15.0	132-142	304-324	5-10	8-13	10-12	20-26	156-166	375-395	12-17	3-8	8-10	35-41
	18.0	132-142	298-318	5-10	7-12	8-10	20-26	159-169	379-399	13-18	3-8	6-8	36-42
100	10.5	136-146	423-443	5-10	11-16	14-16	18-24	Out of Range					
	15.0	136-146	403-423	5-10	9-14	9-11	18-24						
	18.0	136-146	395-415	5-10	8-13	8-10	18-24						

Horizontal 070		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	12.6	Out of Range						66-76	280-300	9-14	8-13	6-8	19-25
	18.0							67-77	282-302	9-14	8-13	4-6	19-25
	21.6							68-78	285-305	10-15	8-13	3-5	20-26
40	12.6	114-124	170-190	26-31	6-11	15-17	22-28	81-91	301-321	10-15	8-13	7-9	23-29
	18.0	114-124	162-182	26-31	5-10	10-12	22-28	83-93	304-324	11-16	8-13	5-7	23-29
	21.6	114-124	158-178	26-31	4-9	8-10	22-28	85-95	307-327	12-17	8-13	4-6	23-29
60	12.6	121-131	229-249	15-20	7-12	14-16	21-27	114-124	329-349	11-16	8-13	9-11	29-35
	18.0	121-131	218-238	15-20	6-11	10-12	21-27	117-127	332-352	12-17	8-13	6-8	29-35
	21.6	121-131	213-233	15-20	5-10	8-10	21-27	119-129	336-356	13-18	8-13	5-7	30-36
80	12.6	129-139	304-324	12-17	7-12	13-15	20-26	148-158	364-384	15-20	8-13	10-12	35-41
	18.0	129-139	289-309	12-17	6-11	9-11	20-26	151-161	368-388	16-21	8-13	7-9	35-41
	21.6	129-139	283-303	12-17	5-10	8-10	20-26	154-164	372-392	17-22	8-13	6-8	36-42
100	12.6	133-143	403-423	12-17	8-13	13-15	18-24	Out of Range					
	18.0	133-143	384-404	12-17	7-12	9-11	18-24						
	21.6	133-143	376-396	12-17	6-11	7-9	18-24						

Table 12: Operating Pressures and Temperatures - Vertical Unit Sizes 015, 019, 024

Vertical 015		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	2.8	Out of Range						71-81	260-280	4-9	4-9	6-8	16-22
	4.0							73-83	263-283	4-9	4-9	4-6	17-23
	4.8							74-84	266-286	5-10	4-9	3-5	17-23
40	2.8	128-138	193-213	10-15	18-23	15-17	20-26	88-98	280-300	5-10	4-9	7-9	19-25
	4.0	128-138	184-204	10-15	16-21	10-12	20-26	90-100	283-303	5-10	4-9	5-7	20-26
	4.8	128-138	180-200	10-15	14-19	8-10	20-26	92-102	286-306	6-11	4-9	4-6	20-26
60	2.8	135-145	260-280	5-10	21-26	14-16	19-25	124-134	306-326	5-10	4-9	10-12	25-31
	4.0	135-145	247-267	5-10	18-23	10-12	19-25	127-137	310-330	6-11	4-9	7-9	25-31
	4.8	135-145	242-262	5-10	16-21	8-10	19-25	129-139	313-333	6-11	4-9	6-8	26-32
80	2.8	144-154	344-364	4-9	22-27	13-15	18-24	160-170	339-359	8-13	4-9	11-13	30-36
	4.0	144-154	328-348	4-9	18-23	9-11	18-24	163-173	343-363	8-13	4-9	8-10	30-36
	4.8	144-154	321-341	4-9	17-22	8-10	18-24	166-176	346-366	9-14	4-9	6-8	31-37
100	2.8	148-158	456-476	4-9	25-30	12-14	16-22	Out of Range					
	4.0	148-158	434-454	4-9	21-26	9-11	16-22						
	4.8	148-158	425-445	4-9	19-24	7-9	16-22						

Vertical 019		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	3.2	Out of Range						73-83	290-310	4-9	7-12	7-9	21-27
	4.5							74-84	293-313	5-10	7-12	5-7	21-27
	5.4							76-86	296-316	5-10	7-12	4-6	21-27
40	3.2	119-129	177-197	11-16	13-18	17-19	22-28	90-100	312-332	5-10	7-12	9-11	24-30
	4.5	119-129	168-188	11-16	11-16	12-14	22-28	92-102	315-335	6-11	7-12	6-8	24-30
	5.4	119-129	165-185	11-16	10-15	10-12	22-28	94-104	319-339	6-11	7-12	5-7	25-31
60	3.2	125-135	238-258	6-11	15-20	17-19	22-28	127-137	341-361	6-11	7-12	11-13	31-37
	4.5	125-135	226-246	6-11	12-17	12-14	22-28	129-139	345-365	6-11	7-12	8-10	31-37
	5.4	125-135	222-242	6-11	11-16	10-12	22-28	132-142	349-369	7-12	7-12	6-8	32-38
80	3.2	134-144	316-336	4-9	15-20	16-18	20-26	163-173	378-398	8-13	7-12	13-15	37-43
	4.5	134-144	301-321	4-9	13-18	11-13	20-26	167-177	382-402	8-13	7-12	9-11	37-43
	5.4	134-144	294-314	4-9	12-17	9-11	20-26	170-180	386-406	9-14	7-12	7-9	38-44
100	3.2	138-148	419-439	4-9	17-22	15-17	19-25	Out of Range					
	4.5	138-148	398-418	4-9	15-20	10-12	19-25						
	5.4	138-148	390-410	4-9	13-18	9-11	19-25						

Vertical 024		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	4.2	Out of Range						70-80	271-291	7-12	2-7	6-8	18-24
	6.0							72-82	274-294	8-13	2-7	4-6	18-24
	7.2							73-83	276-296	9-14	2-7	3-5	18-24
40	4.2	121-131	179-199	11-16	3-8	15-17	21-27	87-97	291-311	9-14	2-7	7-9	21-27
	6.0	121-131	170-190	11-16	2-7	11-13	21-27	89-99	294-314	9-14	2-7	5-7	21-27
	7.2	121-131	166-186	11-16	2-7	9-11	21-27	91-101	297-317	10-15	2-7	4-6	21-27
60	4.2	127-137	240-260	6-11	4-9	15-17	20-26	123-133	319-339	9-14	2-7	9-11	27-33
	6.0	127-137	228-248	6-11	3-8	10-12	20-26	125-135	322-342	10-15	2-7	7-9	27-33
	7.2	127-137	224-244	6-11	3-8	9-11	20-26	128-138	325-345	11-16	2-7	5-7	27-33
80	4.2	136-146	319-339	4-9	4-9	14-16	19-25	158-168	353-373	13-18	2-7	11-13	32-38
	6.0	136-146	303-323	4-9	3-8	10-12	19-25	161-171	356-376	14-19	2-7	8-10	32-38
	7.2	136-146	297-317	4-9	3-8	8-10	19-25	165-175	360-380	15-20	2-7	6-8	33-39
100	4.2	140-150	422-442	4-9	5-10	13-15	17-23	Out of Range					
	6.0	140-150	402-422	4-9	4-9	9-11	17-23						
	7.2	140-150	394-414	4-9	3-8	8-10	17-23						

Operating Pressures and Temperatures

Table 13: Operating Pressures and Temperatures - Vertical Unit Sizes 030, 036, 042

Vertical 030		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	4.9	Out of Range						69-79	274-294	5-10	4-9	6-8	18-24
	7.0							71-81	277-297	6-11	4-9	5-7	18-24
	8.4							72-82	280-300	6-11	4-9	4-6	19-25
40	4.9	120-130	177-197	11-16	7-12	16-18	21-27	86-96	295-315	6-11	4-9	8-10	21-27
	7.0	120-130	168-188	11-16	6-11	11-13	21-27	88-98	298-318	7-12	4-9	6-8	21-27
	8.4	120-130	164-184	11-16	5-10	9-11	21-27	90-100	301-321	7-12	4-9	5-7	22-28
60	4.9	127-137	238-258	6-11	9-14	16-18	20-26	121-131	323-343	7-12	4-9	10-12	27-33
	7.0	127-137	226-246	6-11	7-12	11-13	20-26	124-134	326-346	7-12	4-9	7-9	27-33
	8.4	127-137	222-242	6-11	6-11	9-11	20-26	126-136	329-349	8-13	4-9	6-8	28-34
80	4.9	135-145	316-336	4-9	9-14	15-17	19-25	156-166	357-377	9-14	4-9	12-14	32-38
	7.0	135-145	300-320	4-9	7-12	10-12	19-25	159-169	361-381	10-15	4-9	8-10	33-39
	8.4	135-145	294-314	4-9	7-12	9-11	19-25	163-173	365-385	11-16	4-9	7-9	33-39
100	4.9	139-149	418-438	4-9	10-15	14-16	17-23	Out of Range					
	7.0	139-149	398-418	4-9	9-14	10-12	17-23						
	8.4	139-149	390-410	4-9	8-13	8-10	17-23						

Vertical 036		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	6.3	Out of Range						63-73	255-275	11-16	2-7	5-7	16-22
	9.0							65-75	257-277	11-16	2-7	4-6	17-23
	10.8							66-76	260-280	12-17	2-7	3-5	17-23
40	6.3	122-132	173-193	11-16	7-12	16-18	22-28	79-89	274-294	12-17	2-7	6-8	19-25
	9.0	122-132	164-184	11-16	6-11	11-13	22-28	80-90	277-297	13-18	2-7	5-7	19-25
	10.8	122-132	161-181	11-16	5-10	9-11	22-28	82-92	280-300	14-19	2-7	4-6	20-26
60	6.3	129-139	233-253	6-11	8-13	15-17	21-27	110-120	300-320	13-18	2-7	8-10	25-31
	9.0	129-139	221-241	6-11	7-12	11-13	21-27	113-123	303-323	14-19	2-7	6-8	25-31
	10.8	129-139	217-237	6-11	6-11	9-11	21-27	115-125	306-326	15-20	2-7	5-7	26-32
80	6.3	137-147	309-329	4-9	8-13	14-16	20-26	142-152	332-352	18-23	2-7	10-12	30-36
	9.0	137-147	294-314	4-9	7-12	10-12	20-26	145-155	336-356	19-24	2-7	7-9	30-36
	10.8	137-147	288-308	4-9	6-11	8-10	20-26	148-158	339-359	20-25	2-7	6-8	31-37
100	6.3	141-151	409-429	4-9	10-15	14-16	18-24	Out of Range					
	9.0	141-151	389-409	4-9	8-13	9-11	18-24						
	10.8	141-151	381-401	4-9	7-12	8-10	18-24						

Vertical 042		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	7.4	Out of Range						69-79	263-283	6-11	1-6	5-7	17-23
	10.5							70-80	266-286	7-12	1-6	4-6	17-23
	12.6							72-82	269-289	7-12	1-6	3-5	18-24
40	7.4	122-132	175-195	11-16	9-14	15-17	21-27	85-95	283-303	7-12	1-6	7-9	20-26
	10.5	122-132	166-186	11-16	7-12	11-13	21-27	87-97	286-306	8-13	1-6	5-7	20-26
	12.6	122-132	163-183	11-16	6-11	9-11	21-27	89-99	289-309	9-14	1-6	4-6	21-27
60	7.4	129-139	235-255	6-11	10-15	15-17	21-27	120-130	310-330	8-13	1-6	9-11	26-32
	10.5	129-139	224-244	6-11	8-13	10-12	21-27	123-133	313-333	8-13	1-6	6-8	26-32
	12.6	129-139	219-239	6-11	7-12	9-11	21-27	125-135	317-337	9-14	1-6	5-7	27-33
80	7.4	137-147	312-332	4-9	10-15	14-16	19-25	155-165	343-363	11-16	1-6	10-12	31-37
	10.5	137-147	297-317	4-9	9-14	10-12	19-25	158-168	347-367	12-17	1-6	7-9	32-38
	12.6	137-147	291-311	4-9	8-13	8-10	19-25	161-171	350-370	13-18	1-6	6-8	32-38
100	7.4	141-151	414-434	4-9	12-17	13-15	18-24	Out of Range					
	10.5	141-151	394-414	4-9	10-15	9-11	18-24						
	12.6	141-151	386-406	4-9	9-14	8-10	18-24						

Table 14: Operating Pressures and Temperatures - Vertical Unit Sizes 048, 060, 070

Vertical 048		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	8.4	Out of Range						71-81	273-293	6-11	3-8	6-8	19-25
	12.0							72-82	275-295	7-12	3-8	4-6	19-25
	14.4							74-84	278-298	7-12	2-7	3-5	19-25
40	8.4	123-133	178-198	12-17	8-13	16-18	22-28	88-98	293-313	7-12	3-8	7-9	22-28
	12.0	123-133	169-189	12-17	7-12	11-13	22-28	90-100	296-316	8-13	3-8	5-7	22-28
	14.4	123-133	166-186	12-17	6-11	9-11	22-28	91-101	299-319	8-13	2-7	4-6	23-29
60	8.4	129-139	240-260	6-11	9-14	16-18	22-28	123-133	321-341	8-13	3-8	9-11	28-34
	12.0	129-139	228-248	6-11	8-13	11-13	22-28	126-136	324-344	8-13	3-8	7-9	29-35
	14.4	129-139	223-243	6-11	7-12	9-11	22-28	128-138	327-347	9-14	2-7	5-7	29-35
80	8.4	138-148	318-338	5-10	10-15	15-17	20-26	159-169	355-375	11-16	3-8	11-13	34-40
	12.0	138-148	303-323	5-10	8-13	10-12	20-26	162-172	359-379	11-16	3-8	8-10	34-40
	14.4	138-148	297-317	5-10	7-12	8-10	20-26	165-175	363-383	12-17	2-7	6-8	35-41
100	8.4	142-152	422-442	5-10	11-16	14-16	18-24	Out of Range					
	12.0	142-152	401-421	5-10	9-14	9-11	18-24						
	14.4	142-152	393-413	5-10	8-13	8-10	18-24						

Vertical 060		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	10.5	Out of Range						67-77	282-302	7-12	1-6	6-8	19-25
	15.0							69-79	285-305	8-13	1-6	4-6	19-25
	18.0							70-80	288-308	8-13	1-6	3-5	20-26
40	10.5	118-128	179-199	14-19	9-14	16-18	22-28	83-93	304-324	8-13	1-6	7-9	22-28
	15.0	118-128	170-190	14-19	7-12	11-13	22-28	85-95	307-327	9-14	1-6	5-7	23-29
	18.0	118-128	167-187	14-19	7-12	9-11	22-28	87-97	310-330	10-15	1-6	4-6	23-29
60	10.5	124-134	242-262	8-13	10-15	15-17	21-27	117-127	332-352	9-14	1-6	9-11	29-35
	15.0	124-134	230-250	8-13	8-13	11-13	21-27	120-130	336-356	10-15	1-6	7-9	29-35
	18.0	124-134	225-245	8-13	8-13	9-11	21-27	122-132	339-359	10-15	1-6	5-7	30-36
80	10.5	132-142	321-341	6-11	11-16	14-16	20-26	151-161	368-388	12-17	1-6	11-13	34-40
	15.0	132-142	305-325	6-11	9-14	10-12	20-26	154-164	371-391	13-18	1-6	8-10	35-41
	18.0	132-142	299-319	6-11	8-13	8-10	20-26	157-167	375-395	14-19	1-6	6-8	36-42
100	10.5	136-146	425-445	6-11	12-17	14-16	18-24	Out of Range					
	15.0	136-146	404-424	6-11	10-15	9-11	18-24						
	18.0	136-146	396-416	6-11	9-14	8-10	18-24						

Vertical 070		Full Load Cooling						Full Load Heating					
Entering Water Temp °F	Water Flow GPM	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F	Suction Pressure PSIG	Discharge Pressure PSIG	Superheat	Subcooling	Water Temp Rise °F	Air DB Drop °F
30	12.6	Out of Range						67-77	282-302	7-12	2-7	6-8	20-26
	18.0							68-78	284-304	8-13	2-7	4-6	20-26
	21.6							70-80	287-307	9-14	2-7	3-5	21-27
40	12.6	117-127	171-191	14-19	7-12	15-17	23-29	83-93	303-323	9-14	2-7	7-9	24-30
	18.0	117-127	162-182	14-19	6-11	10-12	23-29	85-95	306-326	9-14	2-7	5-7	24-30
	21.6	117-127	159-179	14-19	5-10	9-11	23-29	86-96	309-329	10-15	2-7	4-6	24-30
60	12.6	124-134	230-250	8-13	8-13	15-17	22-28	116-126	331-351	9-14	2-7	9-11	30-36
	18.0	124-134	219-239	8-13	7-12	10-12	22-28	119-129	335-355	10-15	2-7	6-8	30-36
	21.6	124-134	214-234	8-13	6-11	8-10	22-28	121-131	338-358	11-16	2-7	5-7	31-37
80	12.6	132-142	305-325	6-11	8-13	14-16	21-27	150-160	367-387	13-18	2-7	10-12	36-42
	18.0	132-142	290-310	6-11	7-12	9-11	21-27	153-163	370-390	14-19	2-7	7-9	36-42
	21.6	132-142	284-304	6-11	6-11	8-10	21-27	156-166	374-394	15-20	2-7	6-8	37-43
100	12.6	136-146	405-425	6-11	10-15	13-15	19-25	Out of Range					
	18.0	136-146	385-405	6-11	8-13	9-11	19-25						
	21.6	136-146	377-397	6-11	7-12	7-9	19-25						

Electrical Data

Figure 28: Electrical Data - Horizontal Units, Standard PSC Blower Motor

Unit Size	Voltage Code	Rated Voltage	Compressor		Blower Motor FLA	Blower Motor HP	Total Unit FLA	Min Circuit Amps	Min. Fuse	Max. Fuse
			RLA	LRA						
006	A	115-1-60	Consult Factory							
	D	208/230-1-60								
	E	265/277-1-60								
009	A	115-1-60								
	D	208/230-1-60								
	E	265/277-1-60								
012	A	115-1-60								
	D	208/230-1-60								
	E	265/277-1-60								
015	D	208/230-1-60	5.4	33	1.6	1/5	7.0	8.4	15	20
	E	265/277-1-60	5.0	28	1.2	1/5	6.2	7.5	15	20
019	D	208/230-1-60	7.3	43	1.6	1/5	8.9	10.7	15	20
	E	265/277-1-60	5.9	46	1.2	1/5	7.1	8.6	15	20
024	D	208/230-1-60	8.9	43	4.1	1/3	13.0	15.2	20	25
	F	208/230-3-60	6.3	63	4.1	1/3	10.4	12.0	15	20
	E	265/277-1-60	6.8	46	3.1	1/3	9.9	11.6	15	20
	G	460-60-3	3.1	30	1.3	1/3	4.4	5.2	15	20
030	D	208/230-1-60	11.2	54	4.1	1/3	15.3	18.1	20	25
	F	208/230-3-60	7.0	63	4.1	1/3	11.1	12.9	15	20
	E	265/277-1-60	8.5	46	3.1	1/3	11.6	13.7	15	20
	G	460-60-3	3.6	30	1.3	1/3	4.9	5.8	15	20
036	D	208/230-1-60	14.4	74	5.6	1/2	20.0	23.6	25	35
	F	208/230-3-60	9.1	70	5.6	1/2	14.7	17.0	20	25
	E	265/277-1-60	10.5	67	3.5	1/2	14.0	16.6	20	25
	G	460-60-3	3.9	34	1.9	1/2	5.8	6.8	15	20
042	D	208/230-1-60	15.0	88	5.6	1/2	20.6	24.4	25	35
	F	208/230-3-60	10.1	68	5.6	1/2	15.7	18.2	20	25
	G	460-3-60	4.4	34	3.5	1/2	7.9	9.0	15	20
048	D	208/230-1-60	17.4	84	5.6	1/2	23.0	27.4	30	40
	F	208/230-3-60	10.9	88	5.6	1/2	16.5	19.2	20	30
	G	460-3-60	5.3	44	3.5	1/2	8.8	10.1	15	20
060	D	208/230-1-60	24.9	134	9.2	1	34.1	40.3	45	70
	F	208/230-3-60	16.6	110	9.2	1	25.8	30.0	30	40
	G	460-3-60	7.2	52	3.3	1	10.5	12.3	15	20
070	D	208/230-1-60	27.2	178	9.2	1	36.4	43.2	45	70
	F	208/230-3-60	19.3	136	9.2	1	28.5	33.3	35	50
	G	460-3-60	8.3	66.1	3.3	1	11.6	13.7	15	20

Figure 29: Electrical Data - Horizontal Units, Constant Torque ECM Blower Motor

Unit Size	Voltage Code	Rated Voltage	Compressor		Blower Motor FLA	Blower Motor HP	Total Unit FLA	Min Circuit Amps	Min. Fuse	Max. Fuse
			RLA	LRA						
015	D	208/230-1-60	5.4	29	3.5	1/2	8.9	10.3	15	20
	E	265/277-1-60	5.0	28	3.2	1/2	8.2	9.5	15	20
019	D	208/230-1-60	7.3	43	3.5	1/2	10.8	12.6	15	20
	E	265/277-1-60	5.9	46	3.2	1/2	9.1	10.6	15	20
024	D	208/230-1-60	8.9	43	3.5	1/2	12.4	14.6	15	25
	F	208/230-3-60	6.3	63	3.5	1/2	9.8	11.4	15	20
	E	265/277-1-60	6.8	46	3.2	1/2	10.0	11.7	15	20
	G	460-60-3*	3.1	30	2.1	1/2	5.2	6.0	15	20
030	D	208/230-1-60	11.2	54	3.5	1/2	14.7	17.5	20	25
	F	208/230-3-60	7.0	63	3.5	1/2	10.5	12.3	15	20
	E	265/277-1-60	8.5	45	3.2	1/2	11.7	13.8	15	20
	G	460-60-3*	3.6	30	2.1	1/2	5.7	6.6	15	20
036	D	208/230-1-60	14.4	74	3.5	1/2	17.9	21.5	25	35
	F	208/230-3-60	9.1	70	3.5	1/2	12.6	14.9	15	20
	E	265/277-1-60	10.5	67	3.2	1/2	13.7	16.3	20	25
	G	460-60-3*	3.9	34	2.1	1/2	6.0	7.0	15	20
042	D	208/230-1-60	15.0	88	3.5	1/2	18.5	22.3	25	35
	F	208/230-3-60	10.1	68	3.5	1/2	13.6	16.1	20	25
	G	460/60/3*	4.4	34	2.1	1/2	6.5	7.6	15	20
048	D	208/230-1-60	17.4	84	5.0	1	22.4	26.8	30	40
	F	208/230-3-60	10.9	88	5.0	1	15.9	18.6	20	25
	G	460/60/3*	5.3	44	4.6	3/4	9.9	11.2	15	20
060	D	208/230-1-60	24.9	134	5.0	1	29.9	36.1	35	60
	F	208/230-3-60	16.6	110	5.0	1	21.6	25.8	25	40
	G	460/60/3*	7.2	52	4.6	3/4	11.8	13.6	15	20
070	D	208/230-1-60	27.2	178	5.0	1	32.2	39.0	40	60
	F	208/230-3-60	19.3	136	5.0	1	24.3	29.1	30	45
	G	460/60/3*	8.3	66	4.0	1	12.3	14.4	15	20

*NEUTRAL CONNECTION REQUIRED! All 460 VAC units with constant-torque ECM motors require a four-wire power supply with neutral. The motor is 265-277V/1Ph and is wired between one hot leg and neutral.

Figure 30: Electrical Data - Vertical Units, Standard PSC Blower Motor

Unit Size	Voltage Code	Rated Voltage	Compressor		Blower Motor FLA	Blower Motor HP	Total Unit FLA	Min Circuit Amps	Min. Fuse	Max. Fuse
			RLA	LRA						
006	A	115-1-60	Consult Factory							
	D	208/230-1-60								
	E	265/277-1-60								
009	A	115-1-60								
	D	208/230-1-60								
	E	265/277-1-60								
012	A	115-1-60								
	D	208/230-1-60								
	E	265/277-1-60								
015	D	208/230-1-60	5.4	33	1.6	1/5	7.0	8.4	15	20
	E	265/277-1-60	5.0	28	1.2	1/5	6.2	7.5	15	20
019	D	208/230-1-60	7.3	43	1.6	1/5	8.9	10.7	15	20
	E	265/277-1-60	5.9	46	1.2	1/5	7.1	8.6	15	20
024	D	208/230-1-60	8.9	43	4.1	1/3	13.0	15.2	20	25
	F	208/230-3-60	6.3	63	4.1	1/3	10.4	12.0	15	20
	E	265/277-1-60	6.8	46	3.1	1/3	9.9	11.6	15	20
	G	460-60-3	3.1	30	1.3	1/3	4.4	5.2	15	20
030	D	208/230-1-60	11.2	54	4.1	1/3	15.3	18.1	20	25
	F	208/230-3-60	7.0	63	4.1	1/3	11.1	12.9	15	20
	E	265/277-1-60	8.5	46	3.1	1/3	11.6	13.7	15	20
	G	460-60-3	3.6	30	1.3	1/3	4.9	5.8	15	20
036	D	208/230-1-60	14.4	74	5.6	1/2	20.0	23.6	25	35
	F	208/230-3-60	9.1	70	5.6	1/2	14.7	17.0	20	25
	E	265/277-1-60	10.5	67	3.5	1/2	14.0	16.6	20	25
	G	460-60-3	3.9	34	1.9	1/2	5.8	6.8	15	20
040	D	208/230-1-60	Consult Factory							
	F	208/230-3-60								
	G	460-3-60								
042	D	208/230-1-60	15.0	88	5.6	1/2	20.6	24.4	25	35
	F	208/230-3-60	10.1	68	5.6	1/2	15.7	18.2	20	25
	G	460-3-60	4.4	34	3.5	1/2	7.9	9.0	15	20
048	D	208/230-1-60	17.4	84	5.6	1/2	23.0	27.4	30	40
	F	208/230-3-60	10.9	88	5.6	1/2	16.5	19.2	20	30
	G	460-3-60	5.3	44	3.5	1/2	8.8	10.1	15	20
060	D	208/230-1-60	24.9	134	9.2	1	34.1	40.3	45	70
	F	208/230-3-60	16.6	110	9.2	1	25.8	30.0	30	40
	G	460-3-60	7.2	52	3.3	1	10.5	12.3	15	20
070	D	208/230-1-60	27.2	178	9.2	1	36.4	43.2	45	70
	F	208/230-3-60	19.3	136	9.2	1	28.5	33.3	35	50
	G	460-3-60	8.3	66.1	3.3	1	11.6	13.7	15	20

Figure 31: Electrical Data - Vertical Units, Constant Torque ECM Blower Motor

Unit Size	Voltage Code	Rated Voltage	Compressor		Blower Motor FLA	Blower Motor HP	Total Unit FLA	Min Circuit Amps	Min. Fuse	Max. Fuse
			RLA	LRA						
015	D	208/230-1-60	5.4	29	3.5	1/2	8.9	10.3	15	20
	E	265/277-1-60	5.0	28	3.2	1/2	8.2	9.5	15	20
019	D	208/230-1-60	7.3	43	3.5	1/2	10.8	12.6	15	20
	E	265/277-1-60	5.9	46	3.2	1/2	9.1	10.6	15	20
024	D	208/230-1-60	8.9	43	3.5	1/2	12.4	14.6	15	25
	F	208/230-3-60	6.3	63	3.5	1/2	9.8	11.4	15	20
	E	265/277-1-60	6.8	46	3.2	1/2	10.0	11.7	15	20
	G	460-60-3	3.1	30	2.1	1/2	5.2	6.0	15	20
030	D	208/230-1-60	11.2	54	3.5	1/2	14.7	17.5	20	25
	F	208/230-3-60	7.0	63	3.5	1/2	10.5	12.3	15	20
	E	265/277-1-60	8.5	45	3.2	1/2	11.7	13.8	15	20
	G	460-60-3	3.6	30	2.1	1/2	5.7	6.6	15	20
036	D	208/230-1-60	14.4	74	3.5	1/2	17.9	21.5	25	35
	F	208/230-3-60	9.1	70	3.5	1/2	12.6	14.9	15	20
	E	265/277-1-60	10.5	67	3.2	1/2	13.7	16.3	20	25
	G	460-60-3	3.9	34	2.1	1/2	6.0	7.0	15	20
040	D	208/230-1-60	Consult Factory							
	F	208/230-3-60								
	G	460-3-60								
042	D	208/230-1-60	15.0	88	3.5	1/2	18.5	22.3	25	35
	F	208/230-3-60	10.1	68	3.5	1/2	13.6	16.1	20	25
	G	460/60/3	4.4	34	2.1	1/2	6.5	7.6	15	20
048	D	208/230-1-60	17.4	84	5.0	1	22.4	26.8	30	40
	F	208/230-3-60	10.9	88	5.0	1	15.9	18.6	20	25
	G	460/60/3	5.3	44	4.6	3/4	9.9	11.2	15	20
060	D	208/230-1-60	24.9	134	5.0	1	29.9	36.1	35	60
	F	208/230-3-60	16.6	110	5.0	1	21.6	25.8	25	40
	G	460/60/3	7.2	52	4.6	3/4	11.8	13.6	15	20
070	D	208/230-1-60	27.2	178	5.0	1	32.2	39.0	40	60
	F	208/230-3-60	19.3	136	5.0	1	24.3	29.1	30	45
	G	460/60/3	8.3	66	4.0	1	12.3	14.4	15	20

*NEUTRAL CONNECTION REQUIRED! All 460 VAC units with constant-torque ECM motors require a four-wire power supply with neutral. The motor is 265-277V/1Ph and is wired between one hot leg and neutral.

Blower Performance Tables

Figure 32: Blower Performance, Standard PSC Blower Motor

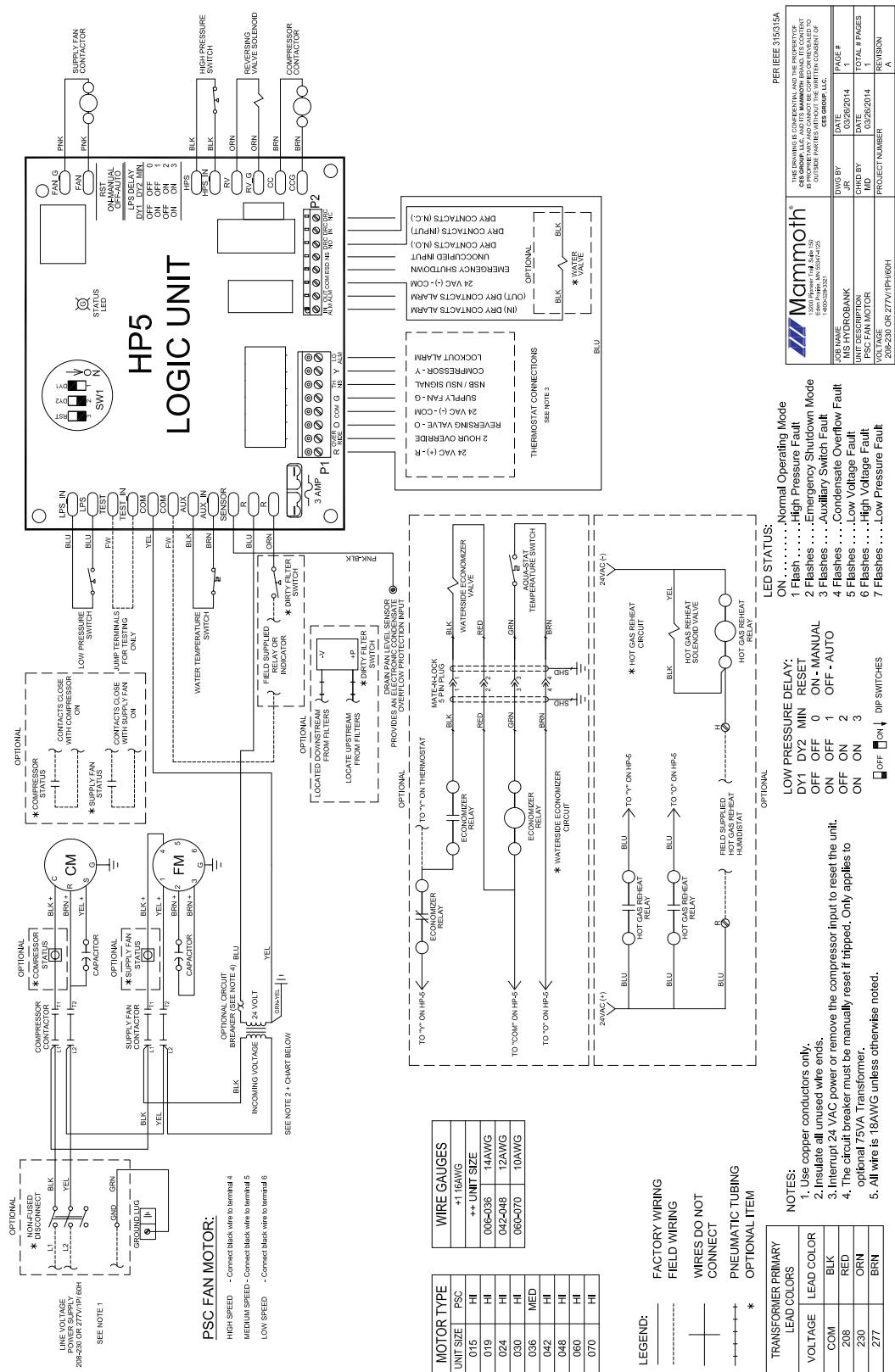
Unit Size	Fan Speed	Rated Airflow	Airflow (cfm) at Listed External Static Pressure (inches of water column)																		
			0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00
006	Lo	Consult Factory																			
	Med																				
	Hi																				
009	Lo																				
	Med																				
	Hi																				
012	Lo																				
	Med																				
	Hi																				
015	Lo	500	-	-	-	-	490	484	477	454	431	399	354	309	-	-	-	-	-	-	-
	Med		652	651	647	636	624	597	569	540	498	450	401	351	-	-	-	-	-	-	-
	Hi		790	778	765	735	705	674	638	594	549	503	456	402	342	-	-	-	-	-	-
019	Lo	600	-	-	481	479	477	475	473	471	464	443	410	375	340	-	-	-	-	-	-
	Med		-	-	-	620	619	618	618	617	610	580	545	490	434	376	-	-	-	-	-
	Hi		843	839	836	828	815	800	777	755	728	686	642	596	522	444	361	-	-	-	-
024	Lo	800	768	765	761	757	749	734	720	696	671	642	-	-	-	-	-	-	-	-	
	Med		976	964	947	930	909	885	861	831	794	757	719	663	-	-	-	-	-	-	
	Hi		1,126	1,102	1,076	1,050	1,023	991	958	925	890	848	791	742	667	-	-	-	-	-	
030	Lo	1000	-	701	699	695	690	678	662	646	617	587	553	-	-	-	-	-	-	-	
	Med		-	929	923	915	903	887	868	849	814	773	731	659	-	-	-	-	-	-	
	Hi		1,161	1,155	1,148	1,137	1,115	1,093	1,071	1,043	1,006	970	922	860	777	-	-	-	-	-	
036	Lo	1200	-	-	-	-	1,289	1,288	1,280	1,264	1,246	1,215	1,185	1,151	1,109	1,066	1,023	-	-	-	-
	Med		1,535	1,530	1,517	1,503	1,484	1,462	1,439	1,412	1,383	1,351	1,306	1,261	1,215	1,157	-	-	-	-	
	Hi		1,743	1,716	1,686	1,656	1,625	1,591	1,558	1,524	1,479	1,429	1,379	1,328	1,265	-	-	-	-	-	
042	Lo	1400	-	-	-	-	-	1,288	1,282	1,265	1,249	1,218	1,187	1,154	1,112	1,069	1,026	-	-	-	-
	Med		1,536	1,533	1,519	1,506	1,488	1,466	1,443	1,416	1,387	1,357	1,311	1,266	1,220	1,162	-	-	-	-	
	Hi		1,750	1,723	1,693	1,663	1,632	1,598	1,564	1,531	1,487	1,437	1,386	1,335	1,272	1,202	-	-	-	-	
048	Lo	1600	-	-	-	-	-	-	-	-	1,289	1,288	1,273	1,255	1,227	1,191	1,153	1,102	1,051	1,000	-
	Med		-	-	-	-	1,538	1,535	1,528	1,514	1,499	1,475	1,449	1,420	1,387	1,348	1,291	1,234	1,163	-	
	Hi		-	1,857	1,845	1,825	1,805	1,778	1,749	1,716	1,680	1,643	1,601	1,559	1,516	1,451	1,385	1,318	1,220	-	
060	Lo	2000	1,328	1,314	1,300	1,286	1,272	1,254	1,234	1,213	1,185	1,152	1,117	1,074	1,031	982	931	882	837	791	746
	Med		1,732	1,714	1,697	1,672	1,647	1,621	1,566	1,509	1,452	1,391	1,330	1,268	1,208	1,148	1,087	1,026	964	884	-
	Hi		2,108	2,078	2,047	2,014	1,951	1,881	1,806	1,731	1,654	1,572	1,485	1,394	1,303	1,211	1,135	1,058	981	887	-
070	Lo	2200	1,533	1,500	1,467	1,434	1,401	1,373	1,345	1,317	1,285	1,252	1,219	1,188	1,157	1,124	1,092	1,059	1,033	1,011	-
	Med		-	1,900	1,875	1,848	1,821	1,793	1,768	1,743	1,718	1,693	1,658	1,621	1,562	1,496	1,429	1,345	1,246	1,149	1,090
	Hi		-	2,396	2,380	2,365	2,325	2,285	2,246	2,200	2,129	2,057	1,985	1,913	1,839	1,753	1,656	1,558	1,459	1,359	1,258

Figure 33: Blower Performance Data, Constant Torque ECM Blower Motor

Unit Size	Tap #	Rated Airflow	Airflow (cfm) at Listed External Static Pressure (inches of water column)																		
			0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00
015	1	500	-	-	528	512	496	480	464	449	434	421	408	-	-	-	-	-	-	-	-
	2		-	626	611	598	586	574	561	549	536	523	506	-	-	-	-	-	-	-	-
	3		672	670	668	661	651	636	621	610	599	572	-	-	-	-	-	-	-	-	-
	4		686	684	683	681	669	654	639	622	606	-	-	-	-	-	-	-	-	-	-
	5		687	685	683	681	669	654	-	-	-	-	-	-	-	-	-	-	-	-	-
019	1	600	599	584	569	553	538	524	509	494	478	460	436	412	398	386	373	360	-	-	-
	2		702	688	675	660	645	630	618	605	592	579	566	552	536	518	499	-	-	-	-
	3		766	754	742	728	714	702	691	679	666	654	641	629	616	603	-	-	-	-	-
	4		858	846	834	823	812	802	791	779	768	756	743	728	712	-	-	-	-	-	-
	5		932	923	915	906	897	886	875	857	840	823	804	-	-	-	-	-	-	-	-
024	1	800	631	615	599	586	572	559	545	532	518	505	-	-	-	-	-	-	-	-	-
	2		732	718	704	691	678	665	653	641	628	616	604	-	-	-	-	-	-	-	-
	3		849	836	823	811	798	786	773	759	746	734	721	-	-	-	-	-	-	-	-
	4		932	920	908	895	883	872	862	851	839	827	814	801	-	-	-	-	-	-	-
	5		1,010	998	986	975	964	954	944	934	923	913	-	-	-	-	-	-	-	-	-
030	1	1000	724	704	684	657	635	608	582	566	555	538	-	-	-	-	-	-	-	-	-
	2		988	973	957	941	924	907	891	876	859	838	808	-	-	-	-	-	-	-	-
	3		1,116	1,103	1,089	1,073	1,059	1,045	1,031	1,016	998	985	971	955	939	921	896	-	-	-	-
	4		1,269	1,257	1,245	1,233	1,222	1,205	1,194	1,183	1,172	1,159	1,143	1,129	1,116	1,101	-	-	-	-	-
	5		1,473	1,461	1,449	1,439	1,426	1,413	1,398	1,385	1,316	1,330	1,275	1,252	-	-	-	-	-	-	-
036	1	1200	762	743	719	699	674	647	622	589	570	558	542	-	-	-	-	-	-	-	-
	2		1,034	1,017	1,001	986	970	953	935	916	898	883	865	843	812	-	-	-	-	-	-
	3		1,170	1,154	1,138	1,125	1,111	1,095	1,079	1,063	1,048	1,033	1,017	997	984	967	951	933	910	881	-
	4		1,328	1,314	1,303	1,292	1,278	1,263	1,250	1,236	1,226	1,208	1,195	1,183	1,171	1,156	1,139	1,125	1,110	1,092	-
	5		1,488	1,477	1,465	1,452	1,443	1,429	1,416	1,400	1,386	1,375	1,365	1,352	1,338	1,313	1,289	1,264	1,236	-	-
042	1	1400	763	743	719	699	674	647	622	589	570	558	542	-	-	-	-	-	-	-	-
	2		1,035	1,018	1,002	987	971	954	936	917	898	883	865	844	813	-	-	-	-	-	-
	3		1,171	1,155	1,139	1,125	1,111	1,096	1,080	1,063	1,048	1,033	1,018	998	984	968	951	933	911	881	-
	4		1,329	1,316	1,304	1,293	1,280	1,265	1,251	1,237	1,227	1,210	1,196	1,184	1,172	1,158	1,140	1,126	1,111	1,093	-
	5		1,490	1,479	1,467	1,453	1,444	1,431	1,418	1,403	1,388	1,377	1,366	1,354	1,339	1,316	1,291	1,267	1,239	-	-
060	1	2000	1,313	1,292	1,271	1,251	1,232	1,213	1,192	1,170	1,148	1,127	1,105	1,083	1,062	1,040	1,018	997	976	957	940
	2		1,791	1,774	1,757	1,742	1,726	1,712	1,698	1,682	1,665	1,648	1,632	1,616	1,600	1,583	-	-	-	-	-
	3		2,019	2,003	1,979	1,963	1,951	1,938	1,924	1,911	1,897	1,883	1,831	1,774	1,716	-	-	-	-	-	-
	4		2,133	2,117	2,101	2,087	2,071	2,055	2,036	2,011	1,985	1,937	1,868	1,799	-	-	-	-	-	-	-
	5		2,253	2,239	2,226	2,207	2,181	2,156	2,103	2,048	1,993	1,931	1,861	1,791	1,721	-	-	-	-	-	-
070	1	2200	1,380	1,355	1,332	1,310	1,291	1,271	1,250	1,227	1,203	1,179	1,122	1,065	1,028	997	972	950	930	913	896
	2		1,887	1,869	1,850	1,831	1,811	1,792	1,774	1,755	1,736	1,719	1,708	1,695	1,679	1,663	1,651	1,639	1,620	1,597	-
	3		2,131	2,116	2,096	2,076	2,058	2,040	2,024	2,007	1,991	1,974	1,958	1,942	1,926	1,912	1,897	1,886	1,874	-	-
	4		2,256	2,241	2,225	2,209	2,189	2,170	2,155	2,138	2,120	2,102	2,085	2,069	2,056	2,043	2,007	1,953	1,898	-	-
	5		2,385	2,370	2,355	2,336	2,318	2,300	2,283	2,270	2,258	2,242	2,225	2,195	2,147	2,098	2,031	1,964	1,896	-	-

Typical Wiring Diagrams

Wiring Diagram - PSC Motor, Single-Phase 208-230 or 277V/1PH/60H

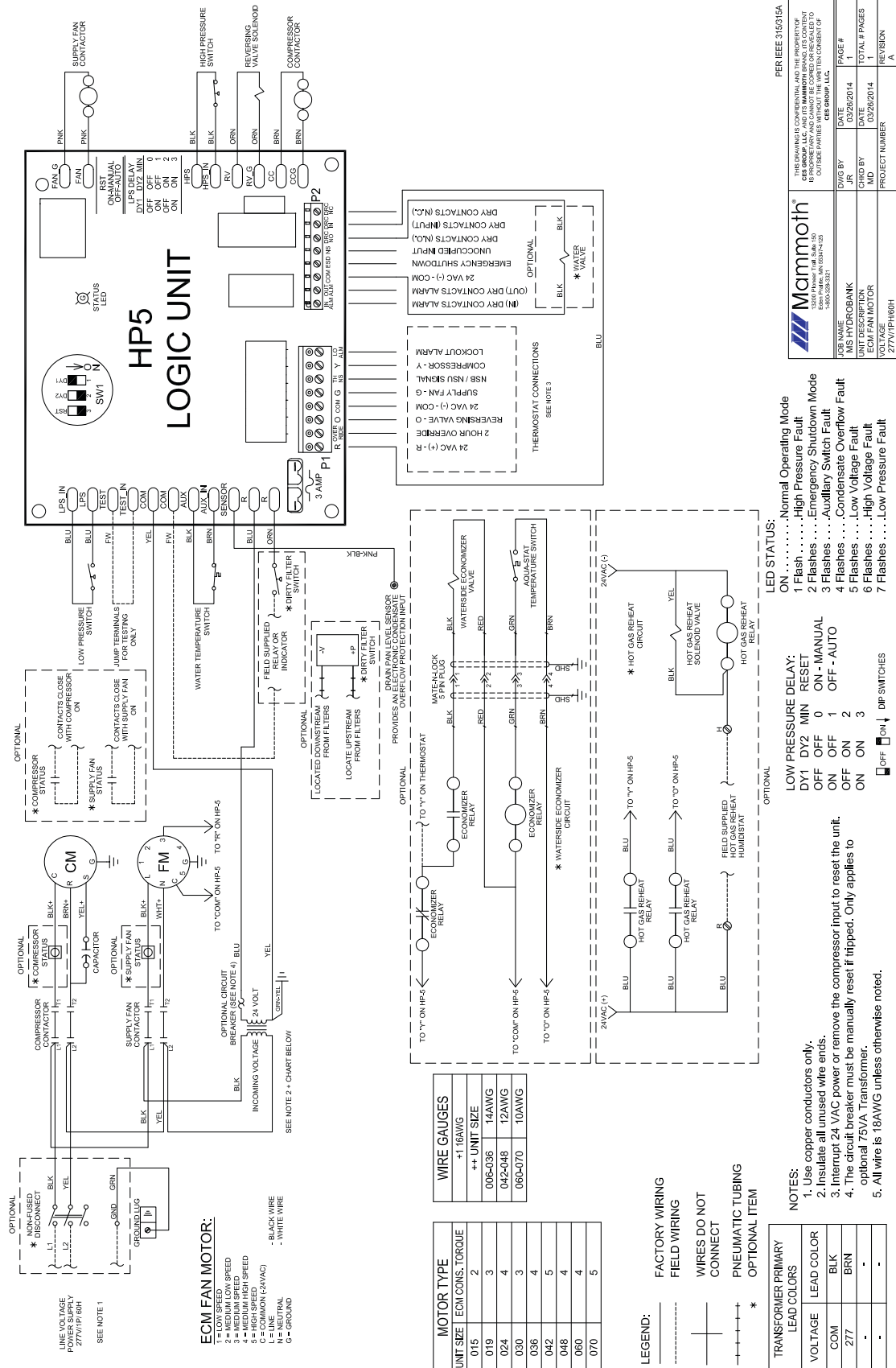


HydroBank MS Installation and Operation Manual MAMM-WSHP-IOM-1MSA (October 2014)

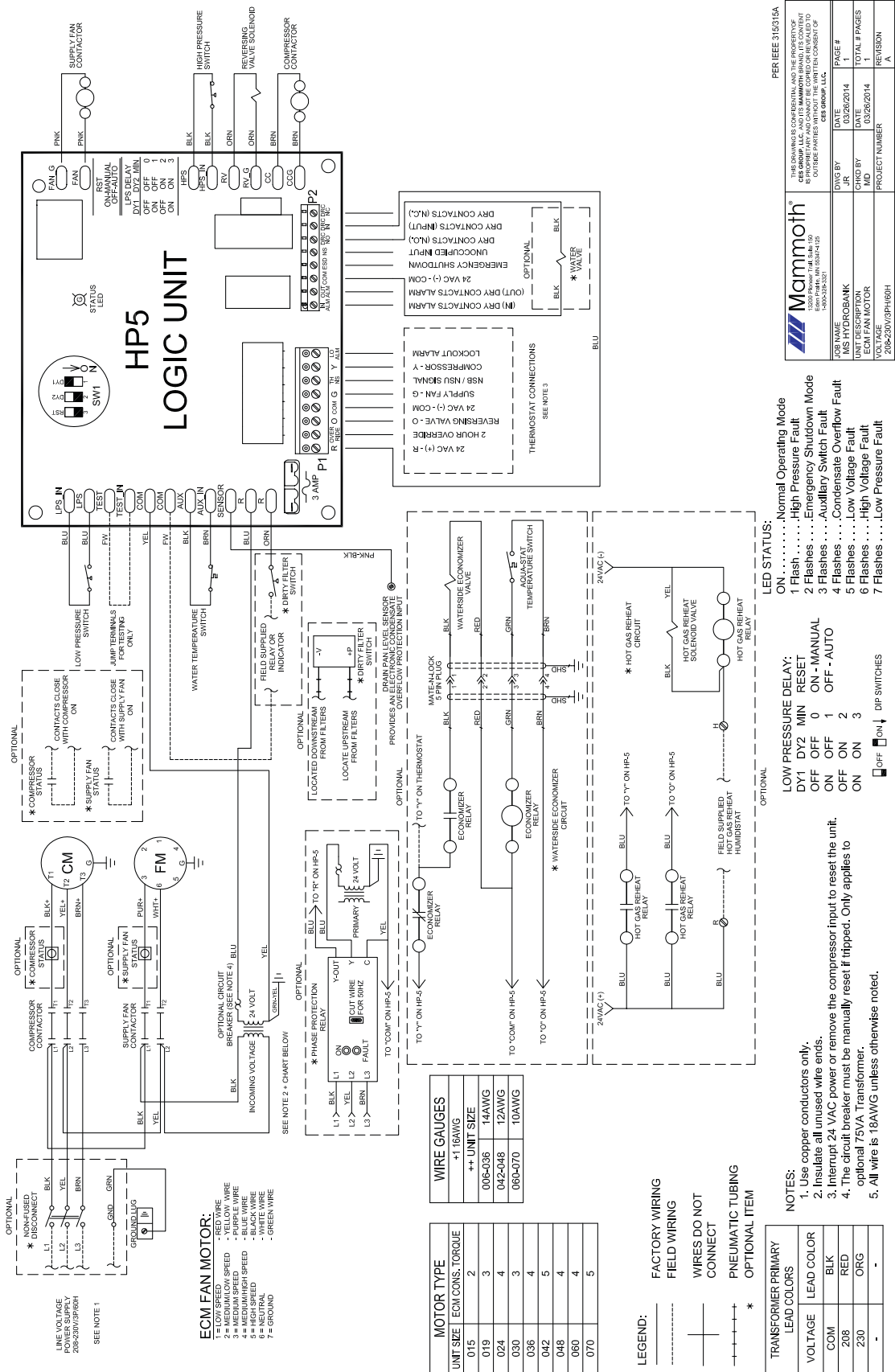




Wiring Diagram - Constant-Torque ECM Motor, Single-Phase 277V/1PH/60H

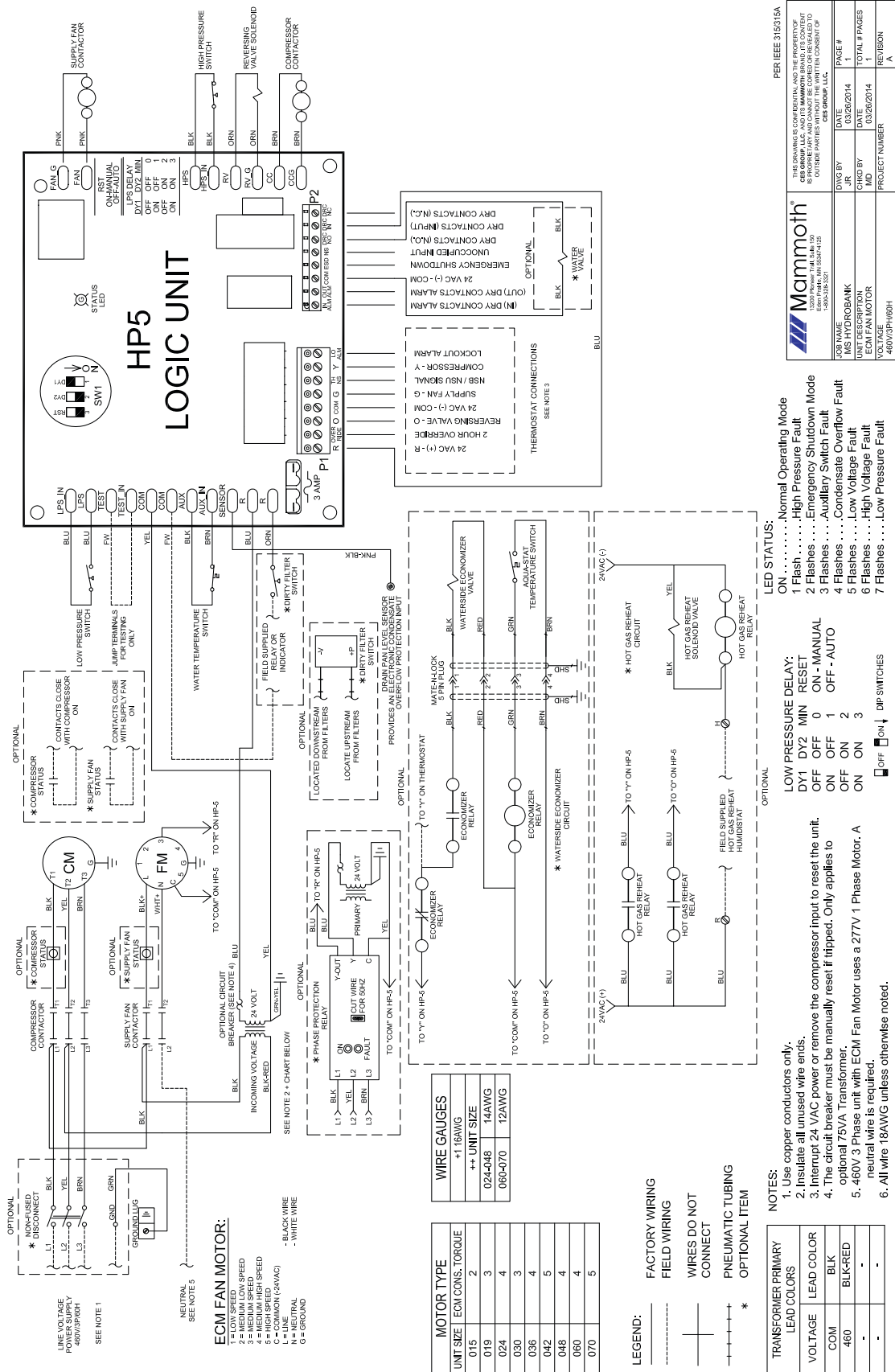


Wiring Diagram - Constant-Torque ECM Motor, Three-Phase 208-230V/1PH/60H



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JOB NAME	DATE
UNIT DESCRIPTION	DATE
ECM FAN MOTOR	03/26/2014
VOLTAGE	MD
208-230V/1PH/60H	03/26/2014
PROJECT NUMBER	1
	REVISION
	A

Wiring Diagram - Constant-Torque ECM Motor, Three-Phase 460V/1PH/60H



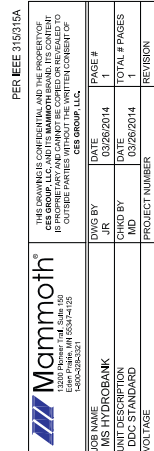
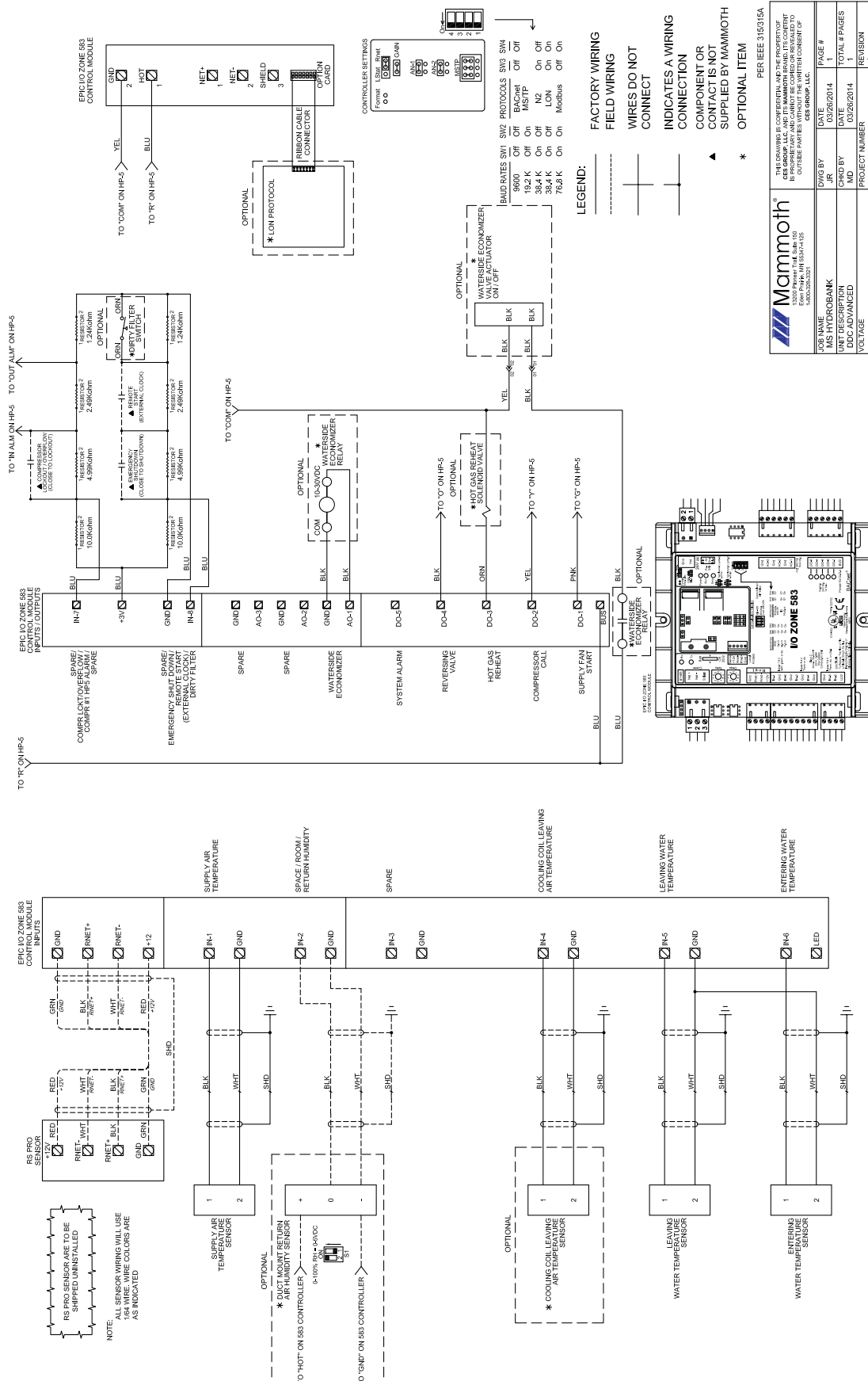


Diagram - EPiC DDC 583 Controller with Analog Outputs



Unit Checkout Sheet

Customer Data

Customer Name _____ Date _____

Address _____

Phone _____ Unit Number _____

Unit Nameplate Data

Make _____ Model Number _____ Serial Number _____

Compressor: RLA _____ LRA _____ Refrig. Charge (oz.) _____

Blower Motor(s): FLA (or NPA) _____ HP _____

Maximum Fuse Size: (Amps) _____ Minimum Circuit Ampacity (Amps) _____

Operating Conditions

Unit Conditions	Cooling Mode	Heating Mode	Measured At:
Entering Air Temperature	_____	_____	_____
Leaving Air Temperature	_____	_____	_____
Entering Fluid Temperature	_____	_____	
Leaving Fluid Temperature	_____	_____	
Fluid Flow (gpm)	_____	_____	
Fluid Side Pressure Drop	_____	_____	

Compressor

Mode	Cooling
Suction Pressure (psig)	_____
Discharge Pressure (psig)	_____
Suction Temp (at compressor)	_____
Discharge Temp (at compressor)	_____
Suction Superheat (at compressor)	_____
Liquid Line Leaving Condenser Temp	_____
Liquid Subcooling	_____

Volts/Amps

Phase	L1	L2	L3
Compressor Volts	_____	_____	_____
Compressor Amps	_____	_____	_____
Blower Volts	_____	_____	_____

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